PTAC

Unconventional Gas Technology Roadmap Workshops

Shale Gas	October 14, 2005
CBM/NGC	October 17, 2005
Tight Gas	October 20, 2005
Gas Hydrates	October 25, 2005
Summary Session	November 4, 2005

Unconventional Gas Technology Roadmap Background

- Western Canada's gas production recently peaked at 6 TCF (16 BCF/day) and is not expected to grow significantly in the medium term
- In the long term, gas supply is forecast to decline to about 4 TCF by 2020. Added conventional supplies from the East Coast and MacKenzie delta may help maintain a national production level up to about 7 TCF per year, but without added reserves from other quarters, the long term position is clear; natural gas supply in Canada, and consequently our contribution to North American energy supply, and valuable exports, will decline in the next two decades unless new supplies from unconventional sources are developed and brought on stream.

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Why a Roadmap?

Technology development holds the key to unlocking reserves, to improve recovery and reduce costs. The development of a "Technology Roadmap" similar to one published for the "oil sands" and "clean coal" industries, is a way to increase awareness of the opportunity offered by unconventional gas, and bring the future development opportunity under the review of a wide stakeholder base. In this way, the industry can gain consensus on the technical challenges, help legislators understand those challenges, and where necessary make an appropriate response to encourage further development of particular resources.

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Unconventional Gas Technology Roadmap Workshop
October 14, 2005, 11:30 am – 4 pm,

NEB Hearing Rooms, Calgary, Alberta

SHALE GAS

The attached notes are from the breakout groups that discussed the technology development needs and opportunities in the future development of Shale Gas.

List of Attendees

Dean Rokosh	**Alberta Geological Survey**
Jeff Sinclair	**Alberta Research Council**
Yunhon Yeung	**Anadarko Petroleum Corporation**
Alain Kahil	**Apache Canada Ltd.**
Tim Leshchyshyn	**BJ Services Company Canada**
Padgett V. Eastman	**Champion Technologies Ltd.**
Rolf D. Wenzel	**Ferus Gas Industries Inc.**
Bob Dixon	**Forward Energy Group Inc.**
Joseph Korol	**GeoKorr Consulting Inc.**
Len Flint	**Lenef Consulting Ltd.**
Olwen Wirth	**MGV Energy Inc.**
Paul R. Mortensen	**National Energy Board**
Bobbi-Lee Feduniak	**National Energy Board**

List of Attendees (continued)

Orlando Huang	**National Energy Board**
J.P. Jepp	**Pembina Institute for Appropriate Development**
Dave Quirk	**Pinnacle Technologies (Canada) Inc.**
Eric Lloyd	**PTAC**
Bob Riopel	**Real Resources Inc.**
John R. Kovacs	**Schlumberger of Canada**
James Brewer	**Shell Canada Limited**
Michael Minchau	**Shell Canada Limited**
Gerhard J. Pflug	**TransCanada Pipelines Ltd.**
Mehran Pooladi-Darvish	**University of Calgary**
John Van Ham	**Van Ham Resources**
Srdjan Borac	**Anadarko Petroleum Corporation**
Mick Somerwil	**MGV Energy Inc.**

Breakout Group Operations

There were two breakout groups, and each was asked to consider the Shale gas needs under 5 categories:

1. **Resource Definition**
2. **Non-Environmental Challenges to development**
   (*not restricted to those with technology development needs*)
3. **Environmental Challenges to development**
   (*not restricted to those with technology development needs*)
4. **Current Technology used in:**
   - Geosciences / Characterization/Modeling
   - Drilling / Completions and Stimulation
   - Lift Mechanisms and Surface Infrastructure
5. **Future Technology Developent Needs / Opportunities in:**
   - Geosciences / Characterization/Modeling
   - Drilling / Completions and Stimulation
   - Lift Mechanisms and Surface Infrastructure

Breakout Group # 1

RESOURCE DEFINITION

Shale gas is essentially natural gas contained within a sequence of predominantly fine grained rocks dominated by shale. The silt or sand content of 'shale' averages about 50 wt. % in many shales of the WCSB, to as high as about 70-80 wt. %, above which the rock may be referred to as shaley silt or shaley sand. *(Source: CSUG)*

Comments:

- be careful about the %s…it's a continuum
- shale is the source rock and the reservoir
- look at the second para in notes that qualifies this resource
- at some stage need to develop understanding of cut off
- review the US definition

NON- ENVIRO DEVELOPMENT CHALLENGES

- defining/characterizing the resource in situ
  - including natural fractures/modelling
- testing protocols
- economics of recovery
- predicting performance
- incentives to develop with technical & and “values”
- ultra-low permeability and means to overcome
- timing .v. alternatives (e.g. LNG)
- comingled production
- the potential/limitations of horizontal drilling
- “generic” drilling technology
- fracturing technology…carrier fluid …propant design
- geophysics/seismic at the macro and micro level
- rig fleet
- pipeline infrastructure .v. location
- drilling & completions
- reporting issues

NON- ENVIRO DEVELOPMENT CHALLENGES continued

- revisit the land tenure system for UG

ENVIRO-BASED DEVELOPMENT CHALLENGES

- some CO_2 emissions possible…
  (but maybe no worse than conventional)
- “noise” from compression of low pressure gas
- environmental footprint ….land disturbance
- water use & disposal / non-saline the biggest challenge
  (especially impact on fresh water aquifers ?)
- flaring
- land clearing
- wildlife in more remote locations

CURRENT RECOVERY TECHNOLOGY

GEOSCIENCES / RESOURCE CHARACTERIZATION / MODELLING

- adaptation of US practice

This group more comfortable thinking “new tech needs”

FUTURE TECH DEVELOPMENT OPPORTUNITIES

GEOSCIENCES / RESOURCE CHRACTERIZATION/ MODELLING

This group more comfortable thinking "new tech needs"

- geophysics/seismic at the macro and micro level
- identifying free gas .v. shale
- revisiting old logs with a new "eyes"
- poor understanding of the minerology & fluids and the interaction
- fracture modelling
- fracturing technology…carrier fluid …propant design
- better characterization & modelling towards forward reliable commercial prediction
  kinetics of desorportion

CURRENT RECOVERY TECHNOLOGY

DRILLING / COMPLETION / STIMULATION

- adaptation of US practice for closest analogue

FUTURE TECH DEVELOPMENT OPPORTUNITIES

DRILLING / COMPLETION / STIMULATION

- drilling…push the envelope…multi-laterals
- drilling successful well cycle time
- managed pressure drilling
- using drill cuttings to confirm the characterization
- a new drilling technology to eliminate the fracturing
- understanding the importance of cementing to successful fracturing
- “cookie cutter” .v. understanding resource differences
- fracturing technology…carrier fluid …propant design
- fracturing in horizontal wells …it may be different
- defining what fracture looks like … insufficient parameters
- lack of multi-disciplinary interraction (D/C/S)

FUTURE TECH DEVELOPMENT OPPORTUNITIES

LIFT MECHANISMS / SURFACE INFRASTRUCTURE

- cheaper compression
- smaller surface facilities …gathering systems
- downhole gas compression
- low pressure liquid lifting…are there NGLs in shale gas
- low volume pumping for liquids

PARKING LOT

- need for more fundamental support for modelling research chair?

Breakout Group # 2

RESOURCE DEFINITION

Shale gas is essentially natural gas contained within a sequence of predominantly fine grained rocks dominated by shale. The silt or sand content of 'shale' averages about 50 wt. % in many shales of the WCSB, to as high as about 70-80 wt. %, above which the rock may be referred to as shaley silt or shaley sand. *(Source: CSUG)*

Comments:

- **Full circle on this one (may have one definition with subdivisions)**
- **Rather than reserve shale gas is a resource**
- **Strict definition (what is a Canadian)**
  - **distinction between shale and silt is an issue**
  - **Amount of carbon may be key to distinction with CBM**
  - **Tight versus shale is another issue**
- **Ways to distinguish shale gas from others**
  - **Carbon percentage cut-off to distinguish**
  - **Rock type versus gas carbon content (yes)**
  - **Permeability**
  - **Trapping mechanism (e.g., adsorption)**
- **Use "predominantly" in the definition for cut off on either side**

NON- ENVIRO DEVELOPMENT CHALLENGES

Size of prize

Issues

- In place resource definition
- Permeability (In-situ)
- In-ability to find good data
- **Co-mingling may be issue and so strict definition may be unhelpful/helpful (depending on perspective)**

Solutions

- Standards for collection and submission criteria
- Shale atlas by type of play (or other data collection tool)
- Fractures
- But respect confidentiality

- Monitoring technology
- Financial implications of scale issue of industry

Don’t have clear notion of definition of shale gas and therefore type of plays

ENVIRO-BASED DEVELOPMENT CHALLENGES

Issues

- **Water Use and Disposal**
  - **Related to drilling techniques**
  - **Related to completion techniques**
  - **Water production**
  - **Water management**
- **Density of drilling**
  - **Well spacing**
- **Ecology**
- **Land Owners**
- **Mitigation of methane migration**

Solutions

- **Re-completion versus abandonment**
- **Water should not be issue on completion side**
- **Is issue on drilling side**
- **Finding the balance (e.g., well spacing?)**

CURRENT RECOVERY TECHNOLOGY

GEOSCIENCES / RESOURCE CHRACTERIZATION/ MODELLING

Are in exploratory phase of shale gas business

- **All examples today are in lower 48**
- **Don't know how Canadian fields will perform**

Completion/optimization (have not optimized, density is issue)

- **Have not optimized yet**
- **Fluid**
- **Stimulation**

Do we have technology today?

- **Are many TOCs, geophysical logs and mud logs and can characterize the potential shale gas resource today**
- **Production data from Barnett and Lewis, and technology is available**

FUTURE TECH DEVELOPMENT OPPORTUNITIES

GEOSCIENCES / RESOURCE CHRACTERIZATION/ MODELLING

Future wish list

- **Fracture identification and mapping techniques (perhaps using downhole camera)**
- **Natural fracture prediction (resolution is an issue)**
- **Real time bottom hole pressure**
- **Permeability (accurate numbers)**
- **Need proven technology to understand homogeneity and rock mechanics**
- **Horizontal drilling and other drilling may be options, but don't have much experience here**
- **Tool for understanding in-situ heterogeneity in all directions**

- **We have many logs that give many traits; we need a tool to combine traits in case of shale (i.e., one log)**
- **Can we use our public database to assess the resource base (using cuttings or core… physical rock)**
- **To get from here to there (need $$$ to test technology)**

CURRENT RECOVERY TECHNOLOGY

DRILLING / COMPLETION / STIMULATION

Do we have technology today?

- **No Canadian examples**
- **How do optimize when cannot characterize methods in Canada**
- **Coil tubing**
- **We can drill these wells, but there is still a question of dollars spent per well**
    - **But need to ID which technology for drilling**
- **Any technology would be play specific**
- **Is it really technology issue or applying the right technique**
- **Pad drilling and some centralization has taken place, industry is improving**
- **New safety technology is being developed**

FUTURE TECH DEVELOPMENT OPPORTUNITIES

DRILLING / COMPLETION / STIMULATION

- **Drilling**
  - **Cutting analysis can help in identification (but blending is an issue)**
  - **Resolution of analysis tools to tell us traits about shales**
  - **Integrated systems to better utilize equipment (centralize equipment)**
  - **Personnel issues safety issues dealt with through technology**
  - **Near-zero footprint**

- **Completion**
  - **Tool or mechanism to view and trace hydraulic fractures**
  - **Tool to understand rock prediction**

  - **To get from here to there (need $$$ to test technology)**

CURRENT RECOVERY TECHNOLOGY

LIFT MECHANISMS / SURFACE INFRASTRUCTURE

Current technology is meeting needs but is not optimal

FUTURE TECH DEVELOPMENT OPPORTUNITIES

LIFT MECHANISMS / SURFACE INFRASTRUCTURE

- **What are we lifting?**
  - **Lifting gas and water**
  - **Don’t have hard examples to draw experience from**

- **Artificial lift (don’t remove water if don’t need to)**
- **Freezing (DOB example)**
- **No moving parts/mechanisms**
- **Something that takes gas only (to mitigate water issue)**

- **To get from here to there (need $$$ to test technology)**