The Duvernay Shale Reserve Evaluator Perspective

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Introduction

- Reserves and Resources Overview
  - Moving from Prospective Resources to Reserves
- Information used in Shale Gas/Oil evaluations
  - The evaluation cycle
- Duvernay Shale Overview
- General observations to date
  - Economic Implications
  - Risks
  - Oil Window Uncertainty
SPE / PRMS System

PRODUCTION

RESERVES

1P

Proved

2P

Probable

3P

Possible

CONTINGENT RESOURCES

1C

SUB-COMMERCIAL

2C

COMMERCIAL

3C

TOTAL PETROLEUM INITIALLY-IN-PLACE (PIIP)

UNRECOVERABLE

PROSPECTIVE RESOURCES

Low Estimate

Best Estimate

High Estimate

UNRECOVERABLE

Range of Uncertainty

Increasing Chance of Commerciality
Critical Data Used to Appraise Shales

• Specialized Core Analysis

• Fluid Composition

• Gas Content (Desorption analysis and Adsorption Isotherm)

• Vitrinite Reflectance

• Rock-Evaluation Pyrolysis

• Mineralogical Analyses
Drill to De-risk

- Initial pilot wells (hopefully) discover the presence of hydrocarbons
- Initial tests/completions establish productivity
- Repeated success and commerciality converts resources into reserves
- Drill at optimal density to de-risk play while minimizing capital expense
  - Required distance between the wells depends on the geology
• Are the results commercially interesting? This means productivity is important.
• Economics should be solid to add major bookings.
  – Regulators are asking for clarity as to whether or not resource is economic and one would expect little market value from an uneconomic resource.
• Use a distance away from tested wells for lands within a fairway.
  – Typically we have used 2-3 miles from tests to assign Contingent Resources, especially early in development.
• Resource assignments based on average performance of wells in region. Select best estimate contingent using expected behavior.
• Check resulting volumetric recovery for the assumed well and frac spacing.
Resource Evaluation Cycle

- Estimated PIIP
  - Assumed petrophysics cutoffs
  - Kerogen density assumptions

- Undeveloped Reserve/Resource Assignments
  - Assign reserves and resources offsetting performance using volumetrics and analogy

- Performance Data
  - Initial Rate assumption
  - Typecurves (Aarps eqn)
  - Terminal Declines

- Recovery Factors
  - Check performance / decline analysis versus PIIP estimates
  - Do these make sense based on produced fluid encountered?
Shale Gas Plays of North America
Where is the Duvernay

- Present over large portion of Alberta
- Not deposited where Leduc reefs and Peace River Arch were present at time of deposition
Gross Thickness

- Can be mapped with high certainty due to previous drilling targeting equivalent or deeper formations
- What about Net / Accessed thickness
  - High stresses in situ, lithology could impact vertical fracture growth
Results To Date (Simonette/Kaybob Area)

- Posted values: average Free Oil-Condensate/Gas Ratios to date (bbl/Mmcf raw gas)
- Does not include additional processed liquids
- Some values are very limited production history

Observations:
- CGR changes within miles
- What is the cause for low yields close to the reef?
What variable are impacting results?

- **Thermal Maturity**
  - Higher maturity leads to
  - Light constituents in situ ("drier" gas)
  - Higher pressures

- **Lithology** (presence of Clays, quartz, TOC)?

- **Fracture design**?

- We are dealing with a very large area so...as development continues would expect to see some “sweet spots” for development and some less prospective regions come into focus
  - (See Montney normalized initial production map)
• Upon depletion recovery will be influenced by phase effects.
• Liquid dropout near wellbore could dramatically influence recovery.
• More liquids = lower gas recovery?
Liquid Yield Impact on Commerciality

• Does higher liquids and less gas impact commerciality?
• Higher Liquid Yields mean less gas recovery required to be commercial
  – Forecast pricing – used positive NPV at 10% Discount rate to imply commerciality (Solid lines)
  – SEC Constant – used positive NPV Undiscounted (Dashed lines)
• Suggests that changing maturity may impact deliverability – but not commerciality
• High quartz content associated with organic matter that has strong adsorption affinities for crude oil
• Interbedded carbonates have little or no association with organic matter and adsorption does not restrict flow

• What does this mean?
  – Will reduced carbonate shedding from reefs limit productivity
  – Will high quartz and TOC contents result in higher adsorption and reduced permeability
  – Will there be little effect as high quartz entails brittleness
    • More extensive fracture networks = more conduits for oil to flow?

• The Truth – we don’t know yet.
• Gross thickness is the easy part
• Vertical Growth?
• Thermal Maturity?
• Liquid yields will likely influence expected gas recovery
• Higher Liquids allow for lower recovery required for commercial success
• Data even more limited in oil window – we don’t know what to expect yet.
Thank You

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