Is This the New Normal?
2017 WCSB Activity Round Up

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WCSB Plays: Hz Wells Drilled since 2005

- Oil Sands
- Horn River
- Mannville
- Heavy Oil
- Williston Basin
- Bakken/Torquay
- Spirit River
- Viking
- Cardium
- Montney
- Duvernay
- Charlie Lk
- Thermal Oil
- Shaunavon
- Miss Subcrops
Outline

• Historical Prices and 2017 Drilling Activity
• 2017 WCSB Production Highlights
• Key Plays
  o Duvernay
  o Montney
  o Cardium
  o Spirit River
  o SE Saskatchewan Mississippian
  o Viking
• Developing Plays
  o Marten Hills Clearwater
• Wrap Up
2017 Drilling Activity
Drilling Activity
1994–2018 WTI Oil Price and Vertical vs Horizontal Spuds

Well data supplied by geoLOGIC; US EIA website
2017 Spuds by Target Zone

8,949 Spuds

2017 Top Zones
- Cardium (284)
- Viking (1,450)
- Spirit River (488)
- Colony-Lloydminster (1,248)
- U Mannville (192)
- McMurray/Dina (1,043)
- Ellerslie (163)
- Shaunavon (155)
- Charlie Lake (92)
- Montney (1,049)
- Ratcliffe/Midale (185)
- Frobisher/Alida (282)
- Lodgepole/Souris Valley (137)
- Bakken/Torquay (348)
- Duvernay (178)
- Leduc (163)
- Other (868)
2017 Production Highlights
Production

Average 3-Month Cumulative (mboe): Wells On-Stream in 2017

Data supplied by geoLOGIC
Production Sum 3-Month Cum (boe): Wells On-Stream in 2017

Data supplied by geoLOGIC
Key Plays
Wells are Deeper
More Expensive

Duvernay
2017 Operators

Data supplied by geoLOGIC
Duvernay
Three Plays: All Different

**Greater Kaybob**
- Liquids-rich gas
- Thick C Shale pay zone
- More silica-rich (fraccability)
- Deeper
- D&C $9-11MM

**Willesden Green**
- Liquids-rich gas
- Thin C Shale pay zone
- Thick A Shale pay zone
- Deeper
- D&C $9-11MM

**East Shale Basin**
- Oil
- More carbonate-rich
- Pay zone upper D unit
- Shallower
- D&C $5.5MM

Powered by IHS data
Modified from Resource Play Overview | November 17, 2016
Duvernay South Oil Play Land Sales

Duvernay 2016+ Land Sales ($/ha)

Duvernay 2016+ Land Sales Acceleration

- Land sale activity peaked in Oct 2017
- Has spread into WSB at Pigeon Lk, Pembina, St. Anne and Paddle River
- Spuds in WSB at Pigeon Lake, Pembina and St. Anne

Data supplied by geoLOGIC

Updated from 2017 Year in Review | January 24, 2018
Duvernay
ESB Increased Oil Rates as Completions Optimized

Completions Trends 2012 to 2017
• Completed lengths
  • 1,400 to 3,000m
• Stages
  • 20 to 55
• Proppant per well
  • 2,500 to 5,000t

D&C Costs
• Drill $1.9MM
• Complete & tie-in $3.6MM
• Total $5.5MM

Data supplied by geoLOGIC
Duvernay Liquids-Rich Gas and South Oil Plays Wrap Up

16-4-62-21W5

Geology

Greater Kaybob
- Overpressured liquids-rich gas
- Up to 60m pay, upper C Shale
- Silica-rich, aids in fracability

Willesden Green
- Overpressured liquids-rich gas
- 5-25m pay, lower A Shale

South Oil Play
- Overpressured oil
- More carbonate-rich
- ESB up to 40m pay, uppermost D Shale
- Shallower – wells less expensive

Completions
- Increasing intensity
  - Proppant/well and stages increasing
Lower Triassic Montney Liquids-Rich Gas and Oil Plays

- Montney Oil Sands
- Spirit River
- Viking
- Heavy Oil
- Cardium
- Williston Basin

Map showing distribution of oil and gas in the region.
2016, 2017, 2018 land sales
Extension of oil play at Valhalla, AB and Tower, BC
Sales align with 60°C isotherm (approx oil window)
(from Progress to Tommy Lakes)
**Montney Liquids-Rich Gas and Oil Plays Wrap Up**

15-25-80-16W6

**Geology**
- Section ~300m thick
- Mapping phase windows is key
- Overpressured
- Silica content variable
  - Distal turbidites (Doe, Mica, other)
  - Bioclastic reservoirs at Montney N
- Potential for expansion with stacked laterals

**Completions**
- Increasing intensity
  - More proppant/well, more stages

Log analysis generated with GeoLog Multimin® Software; Powered by IHS Data
Lower Cretaceous Spirit River Gas Plays

- Spirit River
- Viking
- Oil Sands
- Montney
- Duvernay
- Thermal Oil
- Heavy Oil
- Cardium
- Williston Basin
- Miss Subcrops
Kakwa, Ferrier, Brazeau, and Sundance are focused on sweet spots.

More Marine and More Continental categories are highlighted.

Data supplied by geoLOGIC.
Spirit River
Regional and Local Variability

Coals
Shoreface sands

Falher
Notikewin
Wilrich

Falher Resource Play Overview │ September 21, 2017

Data supplied by geoLOGIC

Nomenclature Challenges

More Marine
More Continental
### Geology
- Three members, stacked sands
- Highly variable regionally, locally
  - 3D seismic, detailed mapping
- Pay can be up to 120m
- Overpressured
- Relatively low liquids yields, but high rates

### Completions
- Mature; designs changing slowly
- High intensity nets high rates
Upper Cretaceous Cardium Oil and Liquids-Rich Gas Plays

- Cardium Oil Sands
- Spirit River
- Montney
- Duvernay
- Viking
- Thermal Oil
- Heavy Oil
- Williston Basin
- Miss Subcrops

Cardium 2017 Operators

Data supplied by geoLOGIC
Cardium
Bioturbated Zone

Upper Cardium
Bioturbated
Lower Cardium

Core Porosity
9-11%

Log Porosity
3-4%

Old Frac Plane
Upper Cardium (5-15% Porosity)
Bioturbated Zone (20-80% Sand)
Lower Cardium (3-6% Porosity)

New Frac Plane
2.5-4.0m
3.0-7.0m
1.5-3.0m
Cardium Oil and Liquids-Rich Gas Plays Wrap Up

11-1-55-18W5

Geology
- Widespread but variable pay thickness (2–20m)
- Potential in low permeability bioturbated zone below the high quality conventional reservoirs and in halo adjacent to conventional reservoirs
- Liquids-rich gas Smoky to Stolberg
  - High rates potential

Completions
- Longer wellbores
- Stages and proppant/well increasing
- Some operators over 100 stages/well

Log analysis generated with GeoLog Multimin® Software; Powered by IHS Data
Viking
2017 Operators

High IPmax wells 1,000+ boepd

Deep Basin & Structural Plays

Most Active

Marine Play

Data supplied by geoLOGIC
Viking
Oil and Liquids-Rich Gas Plays Wrap Up

**3-23-31-21W3**

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**Geology**
- Large areal extent

**Marine**
- Most active zone WCSB
- Pay 5–10m, low rates
- Lowest cost play WCSB

**Deep Basin and Structural**
- Potential for high rates, liquids

**Completions**
- Marine: ERHs confined by spacing units
- Deep Basin: deeper, longer, more intense completions, more $$

Log analysis generated with GeoLog Multimin® Software; Powered by IHS Data
SE Sask Mississippian Subcrops
2017 Operators

2017 Top Operators
- Spartan (136)
- Crescent Point (107)
- Corex (57)
- Tundra (53)
- TORC (32)
- Astra (29)
- Midale (20)
- Highrock (18)
- Villanova 4 (17)
- Ridgeback (13)
- Other (136)

Data supplied by geoLOGIC; Subcrops from Williston Basin TGI
Lodgepole
Emerging Unconventional Oil Play

Flat Lake Land Sale Activity

Target - Organic-rich Viceroy Unit at top of Lodgepole
- Up to 30m thick
- ~5% TOC

Recent work indicates (just) thermally mature
Deposited in topographic lows where Prairie Evaporite Salt dissolved

Four wells on-stream, relatively low rates, but early days
Self-sourcing resource play

Data supplied by geoLOGIC
SE Sask Mississippian Subcrops
Wrap Up

Geology
• Complex lithology, thin pay (<10m)
• Large oil-in-place
• Moderate decline rates

Completions
• Shallow wells, short laterals
• Varying D&C costs
  • Ratcliffe OH—$1.1MM
  • Midale Frac—$1.6MM
  • Frobisher/Alida OH—$0.9MM

Log analysis generated with GeoLog Multimin® Software; Powered by IHS Data
Developing Plays
Clearwater Marten Hills Heavy Oil Activity

Marten Hills Land and Spud Activity

Recent Spur Spuds

Schematic Cross-Section

Clearwater Grand Rapids Cross-Section

Clearwater
- Conventional heavy oil
- Multi-lateral open hole unstimulated completions
- Wells cost $1.1 to $1.5MM

Recent Spur Spuds

IPmax 100-300 bopd
Wrap Up
## 2017 Key Plays Comparison

### Montney Oil
- **MD:** 4,125m
- **Lateral:** 1,625m
- **Pay:** (Oil) 100m
- **Data:** geoLOGIC; Sproule Play Metrics, Operator Websites

### Montney Gas
- **MD:** 4,525m
- **Lateral:** 2,000m
- **Pay:** (Liquids-Rich Gas) 300m
- **Data:** geoLOGIC; Sproule Play Metrics, Operator Websites

### Spirit River
- **MD:** 4,350m
- **Lateral:** 1,275m
- **Pay:** (Gas) 120m
- **Data:** geoLOGIC; Sproule Play Metrics, Operator Websites

### Duvernay Oil
- **MD:** 4,400m
- **Lateral:** 2,150m
- **Pay:** (Oil) 20m
- **Data:** geoLOGIC; Sproule Play Metrics, Operator Websites

### Duvernay Gas
- **MD:** 5,950m
- **Lateral:** 2,250m
- **Pay:** (Liquids-Rich Gas) 20m
- **Data:** geoLOGIC; Sproule Play Metrics, Operator Websites

### Cardium
- **MD:** 3,525m
- **Lateral:** 1,426m
- **Pay:** (Oil, Liquids-Rich Gas) 15m
- **Data:** geoLOGIC; Sproule Play Metrics, Operator Websites

### Viking
- **MD:** 1,600m
- **Lateral:** 600m
- **Pay:** (Oil) 10m
- **Data:** geoLOGIC; Sproule Play Metrics, Operator Websites

### Ratcliffe-Midalie
- **MD:** 3,025m
- **Lateral:** 1,300m
- **Pay:** (Oil) 10m
- **Data:** geoLOGIC; Sproule Play Metrics, Operator Websites

### Froibisher-Alida
- **MD:** 2,050m
- **Lateral:** 700m
- **Pay:** (Oil) 10m
- **Data:** geoLOGIC; Sproule Play Metrics, Operator Websites

### Wells Drilled (2017)
- **Montney Oil:** 171
- **Montney Gas:** 546
- **Spirit River:** 503
- **Duvernay Oil:** 45
- **Duvernay Gas:** 62
- **Cardium:** 283
- **Viking:** 1,453
- **Ratcliffe-Midalie:** 186
- **Froibisher-Alida:** 275

### D&C Costs (MM)
- **Montney Oil:** 2.7
- **Montney Gas:** 4.7
- **Spirit River:** 4.6
- **Duvernay Oil:** 5.5
- **Duvernay Gas:** 10.3
- **Cardium:** 2.3
- **Viking:** 0.6
- **Ratcliffe-Midalie:** 1.3
- **Froibisher-Alida:** 0.9

### IP90 (boepd)
- **Montney Oil:** 255
- **Montney Gas:** 873
- **Spirit River:** 699
- **Duvernay Oil:** 252
- **Duvernay Gas:** 370
- **Cardium:** 213
- **Viking:** 59
- **Ratcliffe-Midalie:** 92
- **Froibisher-Alida:** 78

### Half-Cycle Cost* ($/boe)
- **Montney Oil:** 10,650
- **Montney Gas:** 5,400
- **Spirit River:** 5,100
- **Duvernay Oil:** 21,800
- **Duvernay Gas:** 27,700
- **Cardium:** 10,900
- **Viking:** 9,600
- **Ratcliffe-Midalie:** 14,200
- **Froibisher-Alida:** 11,550

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*Data supplied by geoLOGIC; unless otherwise noted.
1 Data from Sproule Play Metrics, Powered by Catalyst.
2 Data from Company Websites
*For comparative purposes only.
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