

The Emerging Oil Revolution in Western Canada*

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Abstract

While natural gas prices have put a damper on drilling activity, production, and profitability in Western Canada a quiet revolution has been taking place in oil.

This is not the highly publicized, politically charged, environmentally sensitive development in the oil sands of northeast Alberta but the pursuit of conventional oil in low permeability rocks in areas that have been producing from better quality reservoir rock for decades.

The drivers for this activity include:

The evolution of technology to effectively drill and complete low permeability reservoirs;

The prize of light oil that requires very little treatment;

The opportunity to add production in areas that already have trained manpower, infrastructure and a public understanding of the oil business; and

The combination of relatively low risk and cost with high oil prices.

The revolution started in the Bakken Formation in both North Dakota and Saskatchewan; it has since been spreading to formations like the Lower Shaunavon and Cardium across the basin.

This presentation will look at where the activity is taking place, the identification of opportunities, where similar opportunities may occur, and, how significant this activity could be for the oil industry in Western Canada.

Selected References

Russum, D., 2010, Unconventional Gas Reservoirs: How important are they to North America? Some questions we need to answer: CSPG Technical Luncheon, Telus Convention Centre, Calgary, Canada, January 21, 2010, ajm Petroleum Consultants, Web accessed 30 December 2010,

http://www.ajmpc.com/uploads/files/presentations/ajm_pres_2010_01_CSPGEvalUncnvntlGas.pdf

Mackenzie, W. T., and D.A. Russum, D. A., 1976, The Pembina field-Cardium pool, *in* W. Clack and G. Huff, (eds.), Joint Convention on Enhanced Recovery: The Petroleum Society of the Canadian Institute of Mining and Metallurgy and the Canadian Society of Petroleum Geologists, Core Conference, p. A1-A16.

The Emerging Oil Revolution in Western Canada

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13th September, 2010



10 [Ten years of insight and analysis]

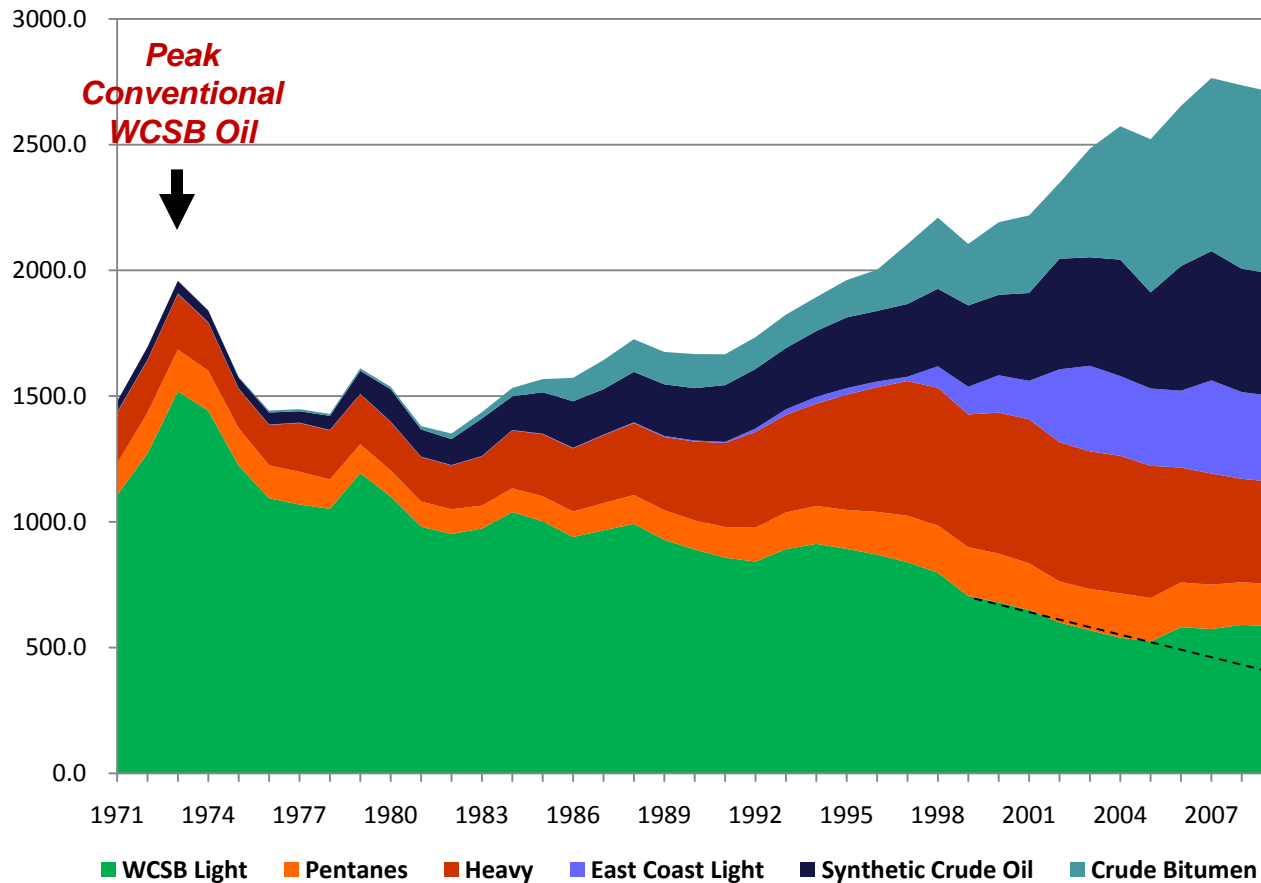
About AJM

- Provide independent engineering, geoscience and economic evaluations to the petroleum and financial industry
 - Leader in probabilistic analysis of reserves and resources, particularly in 'unconventional' reservoirs
- Diverse experience
 - Reserve evaluations in Canada and Internationally
 - Natural gas storage analysis
 - Gas deliverability forecasting
 - Resource potential studies
 - Development feasibility studies
 - Acquisition and Divestiture advisory services
- Provides a unique view of activity in Western Canada

Presentation

- **Canadian Oil Production**
- **Oil Terminology – Back to Basics**
- **Oil in Low Permeability Reservoirs**
 - What is it? How do we find more?
- **The Cardium Revival**
- **Wrap-up**

Historical Canadian Oil Production 1971-2009

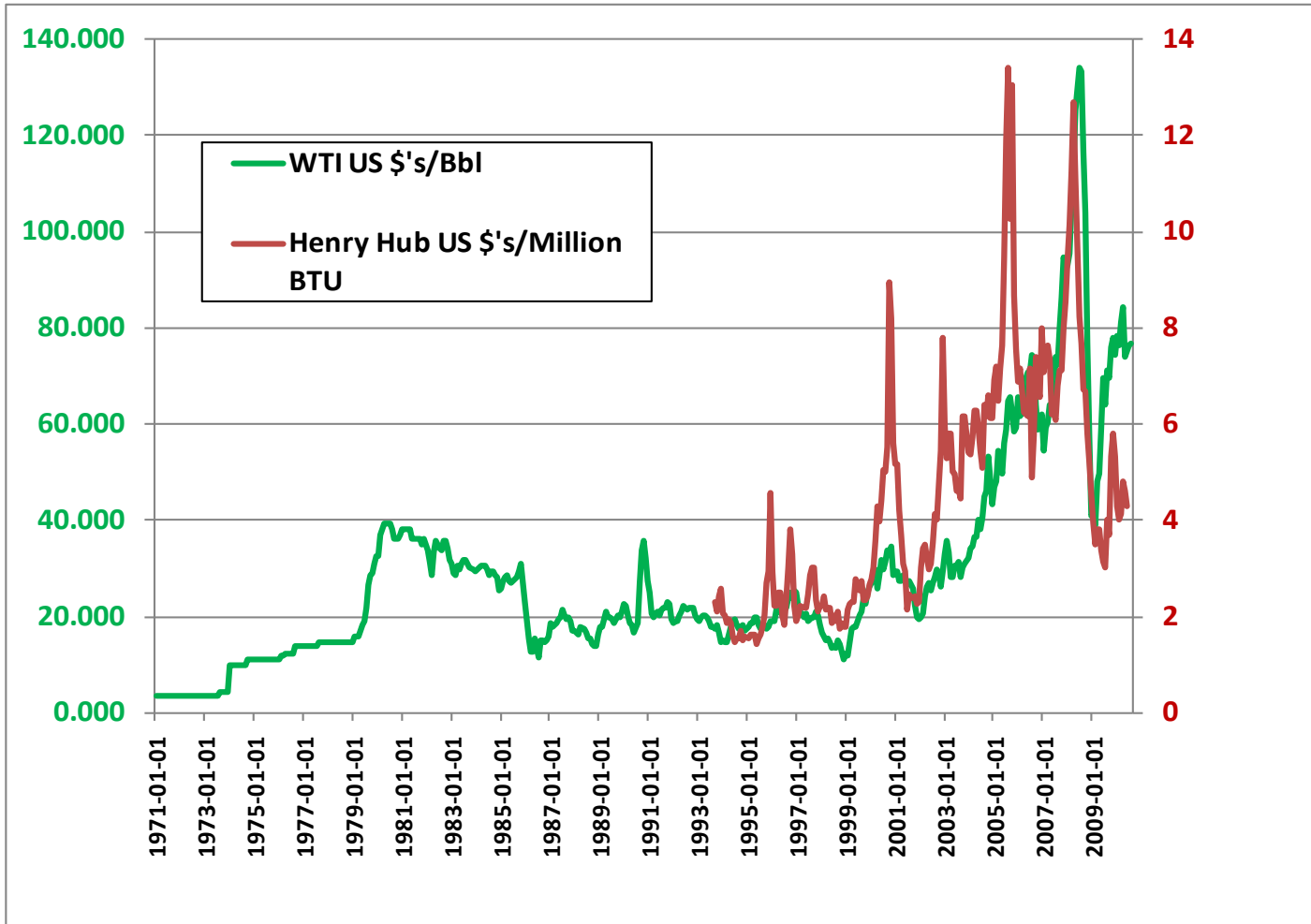


- Western Canada's Conventional light oil had been in decline since 1973
- Majority of upside in WCSB has been in situ and mined bitumen

Significant new areas:

- (EOR using CO₂)
- Conventional oil from low permeability reservoirs

Oil and Gas Price Drives Industry Focus

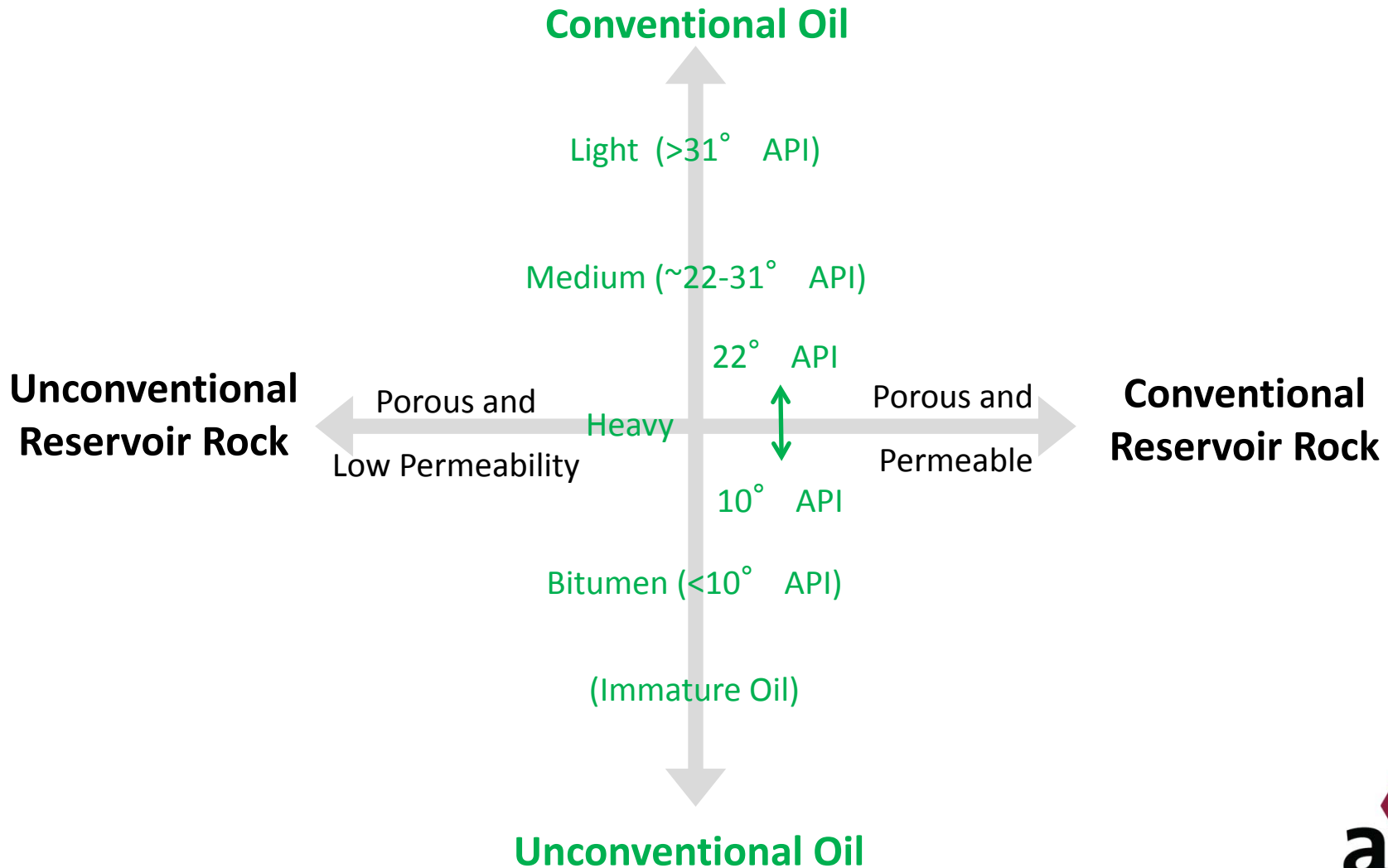


- Oil and Gas have reversed price trends
- Price is current driver for oil activity

Terminology Confusion

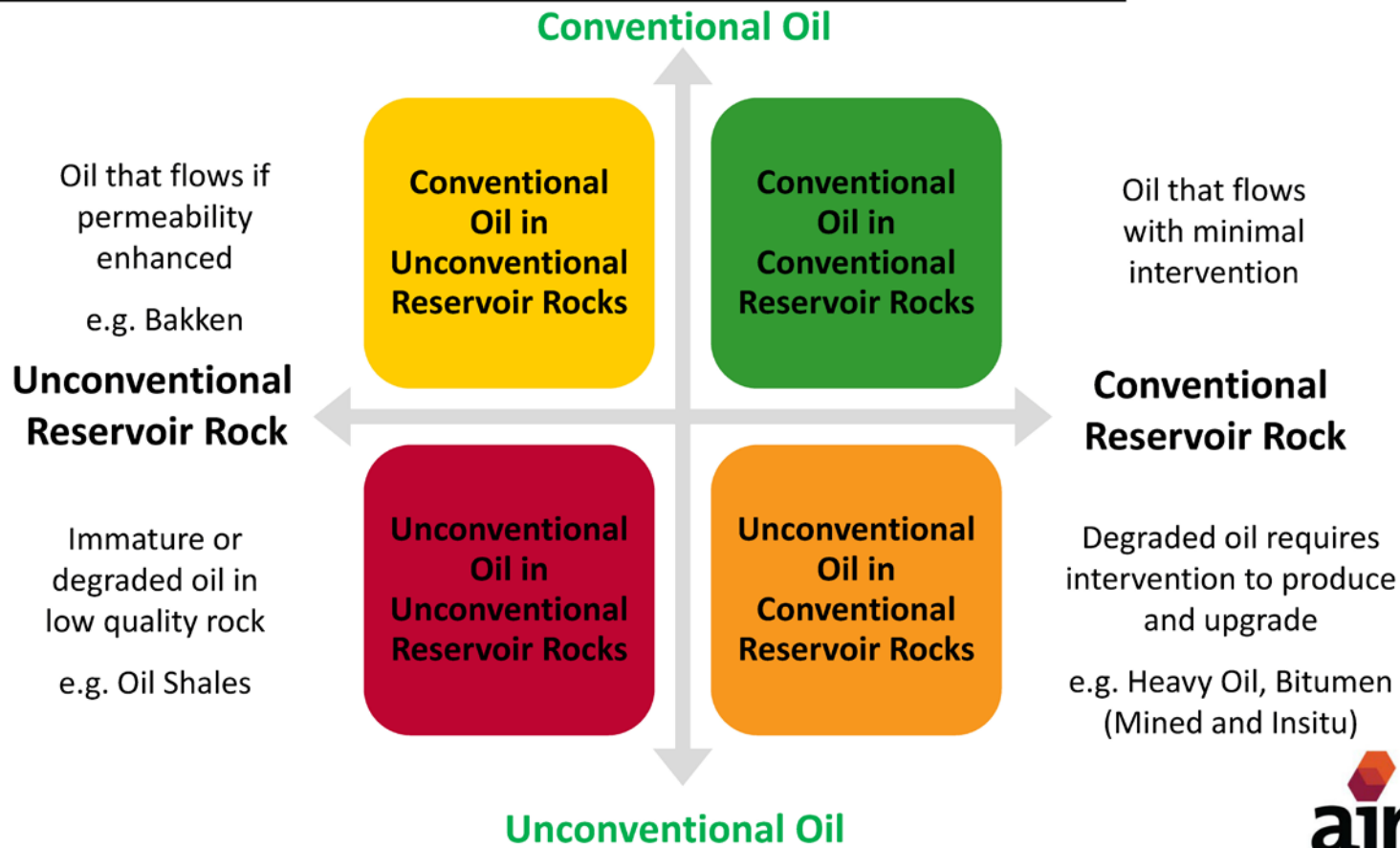
- What is 'unconventional oil' or 'unconventional gas'?
- Shale gas – why not 'sand gas' or 'carbonate gas'?
- What is 'tight oil' or 'tight gas'?
- Confusing the product and the reservoir
- Important – use terminology the general public can understand
 - Confusion breeds suspicion
 - Oil and gas industry already has a PR problem

Re-examining Oil Terminology



Source: Russum Paper published on AJM's Website

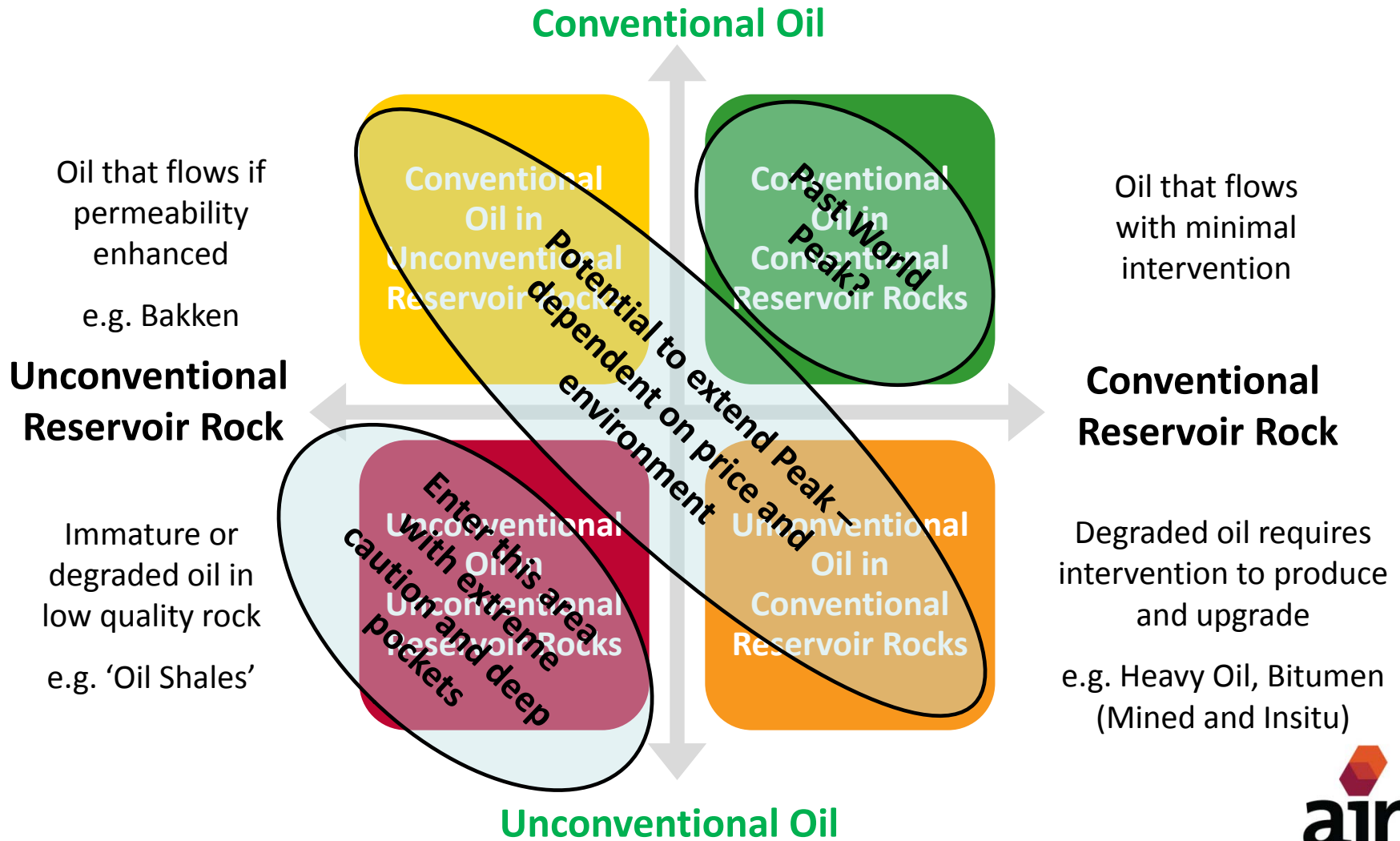
Re-examining Oil Terminology



Source: Russum Paper published on AJM's Website

Notes by Presenter: The light crude oils found in good quality rock as shown in the green box represent the majority of the classical accumulations that have been exploited in the past. If you recall the opening slides where we discussed the relative production volumes of Alberta and Saskatchewan, it's pretty clear that Alberta's conventional oil in conventional reservoirs are in decline. It is well known that Saskatchewan has an abundance of light oils found in tight rock, such as the Bakken and Lower Shanavon formations. These accumulations have the potential to help maintain Saskatchewan's production for a long period of time.

Re-examining Oil Terminology



Source: Russum Paper published on AJM's Website

Benefits of New Technology

- 'Accessing more of the rock'
 - Horizontal drilling vs. vertical drilling (\pm 100 times more rock accessed)
- 'Increasing the permeability so oil can flow'
 - Multi-stage fracturing vs. single-stage fracturing (\pm 10 times more rock accessed)
- Horizontal drilling
 - Evolved in oil, transferred to gas
- Multi-stage fracturing
 - Evolved in gas, transferring to oil

Where Can New Technology Help?

- Numerous types of gas reservoirs
- Thin oil zones over water/under gas
- Accessing heterogeneous oil reservoirs
- Accessing oil in low permeability rock
- Increasing recovery from producing reservoirs:
 - By-passed pay zones
 - Water flooding of low permeability reservoirs
- Enhanced Oil Recovery
 - CO₂ Flooding



Main Focus
of Presentation

Conventional Oil in Low Permeability Rock

Why is it so attractive?

- Relatively shallow
 - Cheap to drill
- Typically in proven areas
 - Risks low
 - Access, equipment, manpower and infrastructure readily available
- Transport of oil relatively easy compared to gas
 - On production within days of drilling
- Typical oil recovery factors are low
 - Leaves considerable volumes of oil to be recovered
- Currently a much more attractive resource than natural gas
 - Price: Oil 20x value of gas (1 barrel oil (\$80) = 20 mcf gas (\$4))
 - Perfect scenario - high initial rates in high price environment

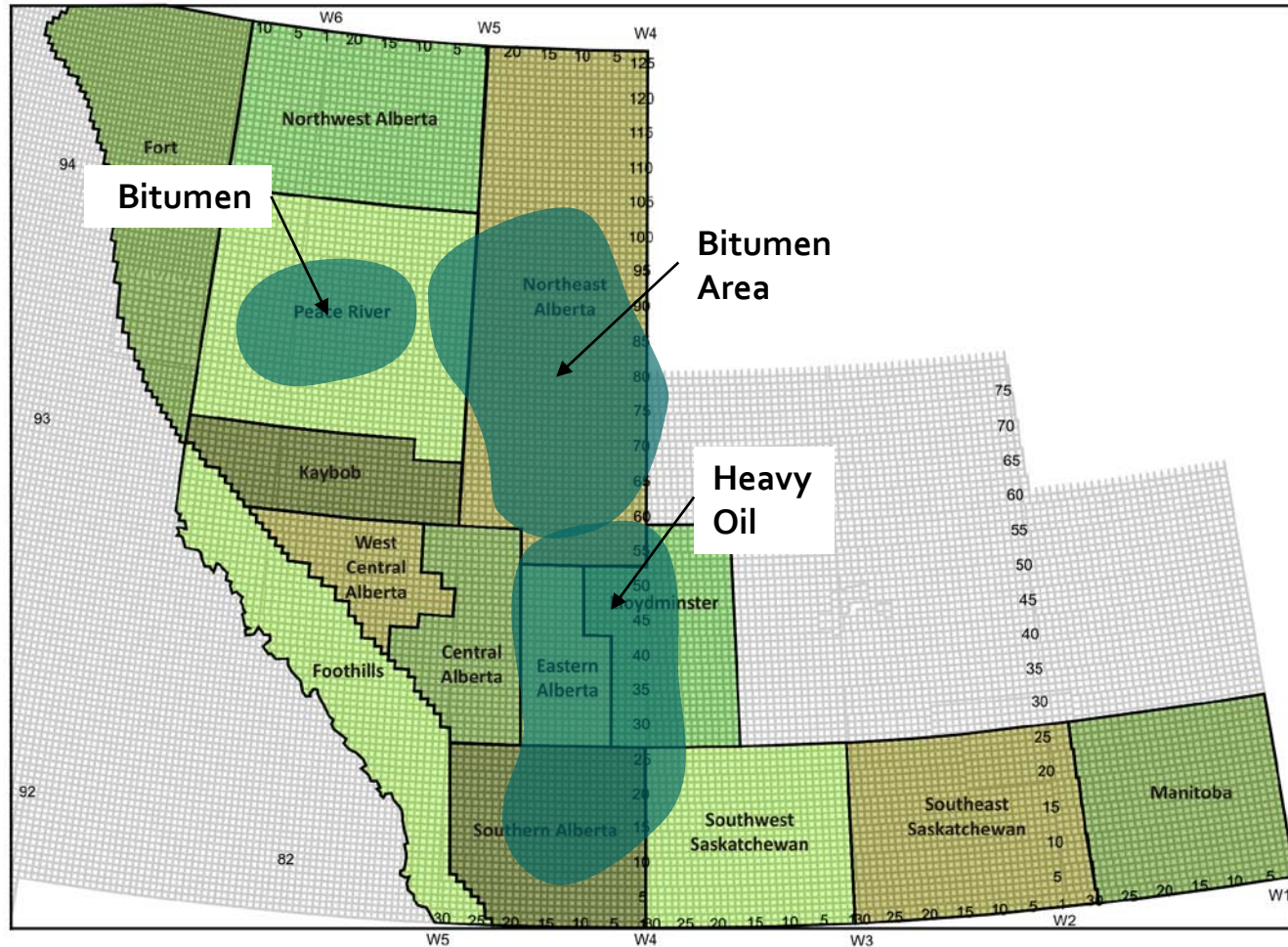
Conventional Oil in Low Permeability Rock

Where should we look?

- Light oil
- Sufficient pore volume of oil to justify the effort
- Permeability too low for unstimulated flow
- Deep enough to avoid groundwater, biodegraded oils and gain benefit of horizontal technology
- Shallow enough to stay in oil window and minimize horizontal drilling problems
- Vertical well control
- Reservoir continuity
- Good access and infrastructure
- Isolated from water
- Rock prospective for artificial fracturing

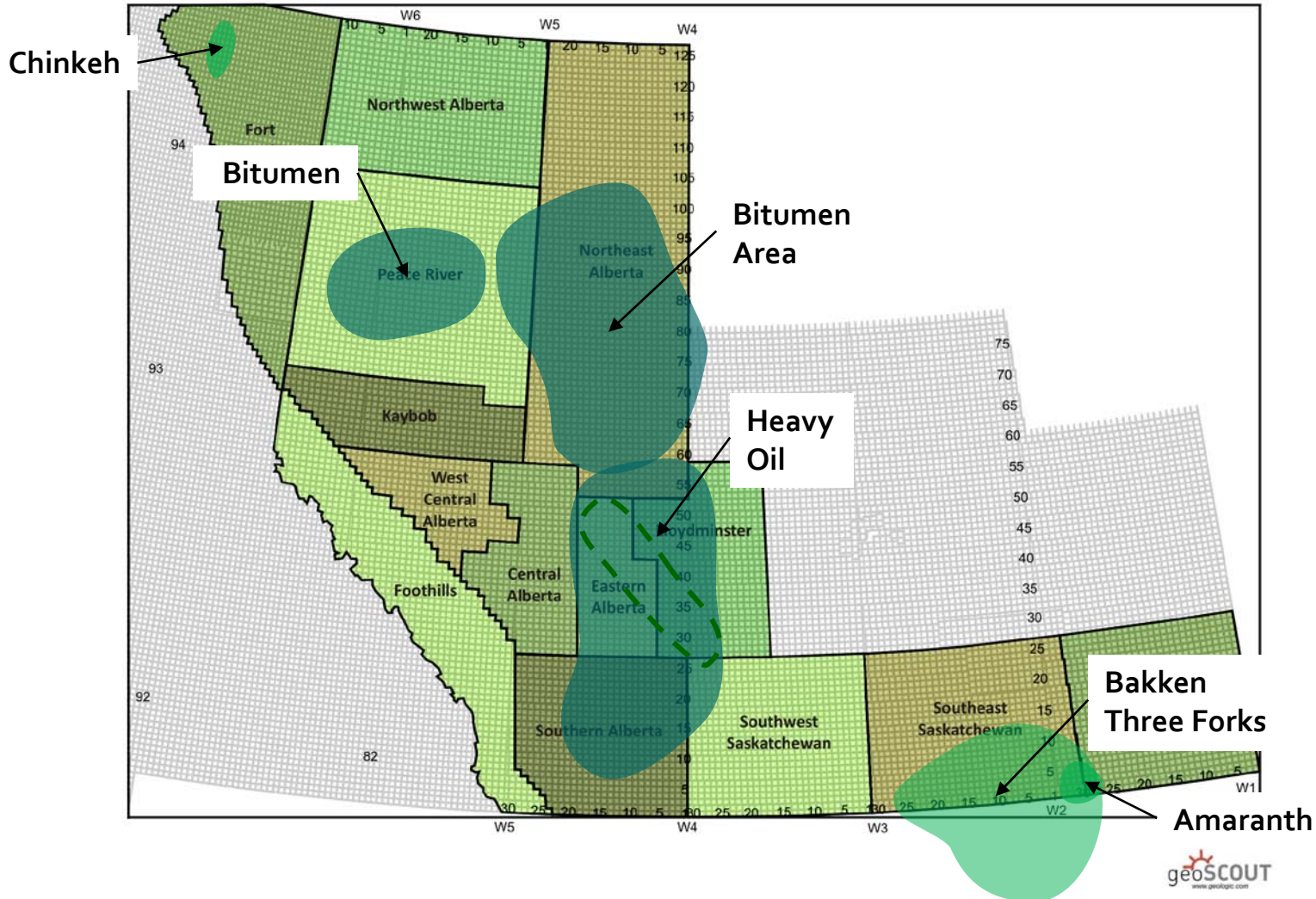
Conventional Oil in Low Permeability Rock

Where does this oil occur?



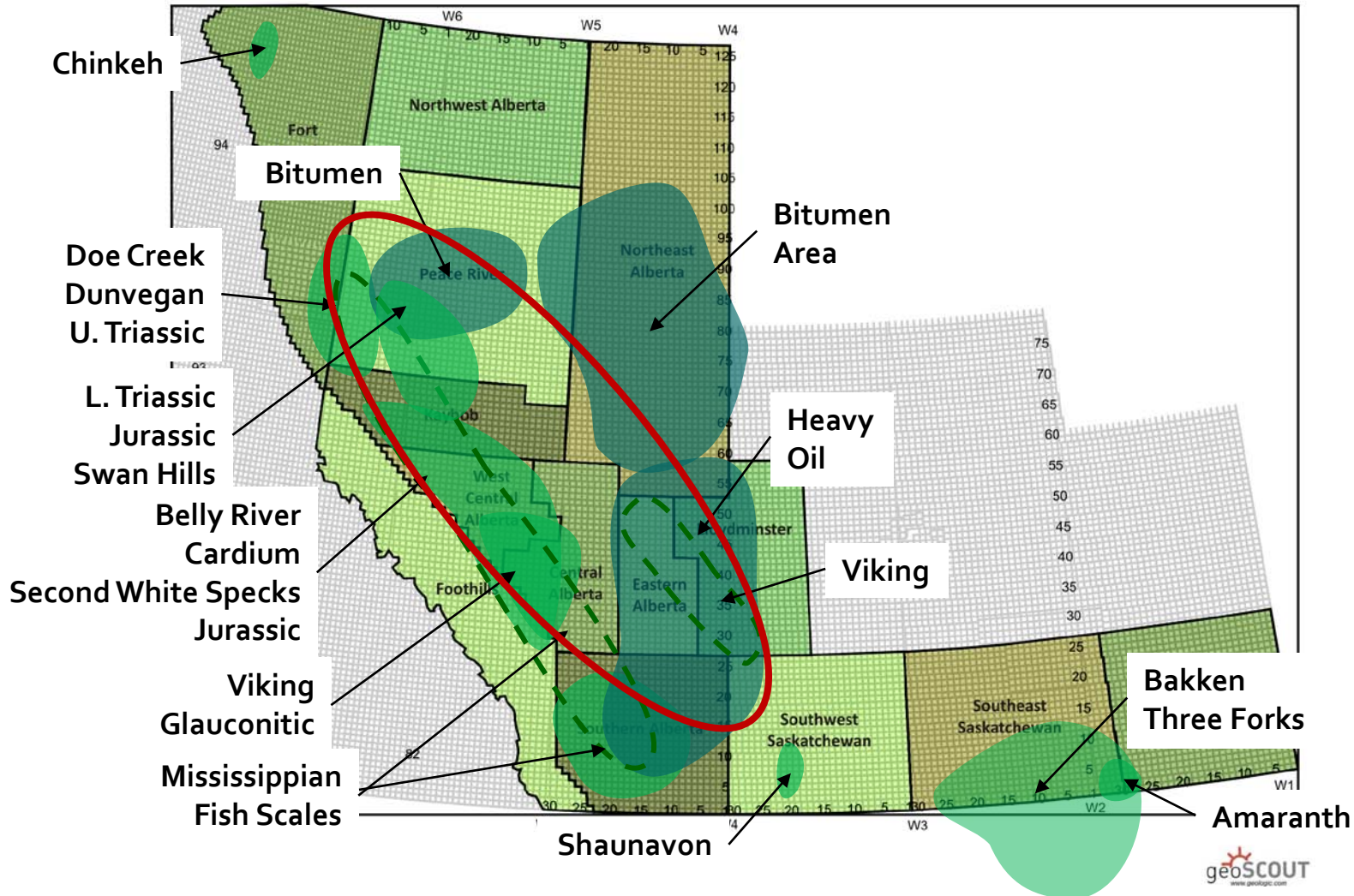
Conventional Oil in Low Permeability Rock

Where does this oil occur?



Conventional Oil in Low Permeability Rock

Where does this oil occur?



Alberta has enormous potential!

Examples – Conventional Oil in Unconventional Reservoirs

Saskatchewan and Manitoba have led the way

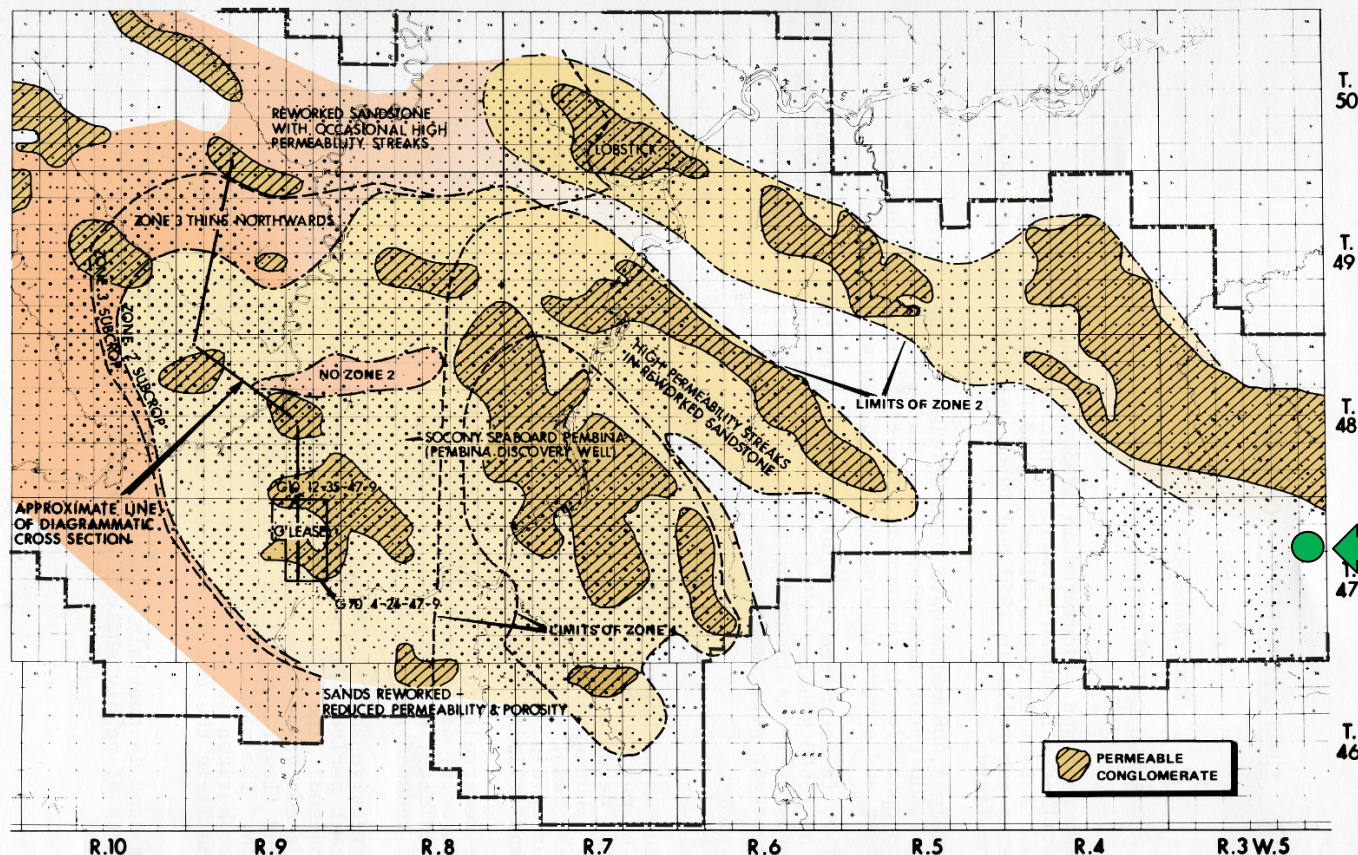
- Bakken/Three Forks – Mississippian/Devonian (Saskatchewan)
- Shaunavon – Jurassic (Saskatchewan)
- Amaranth/Spearfish – Jurassic/Triassic (Manitoba)
- Viking – Cretaceous (Saskatchewan -> Alberta)

Recent activity:

- Cardium – Cretaceous (Alberta) - 224 wells RR 2010 to mid Aug, >\$560MM (DOB, Aug 19 2010)
- Swan Hills – Platform plays (Arcan) - Alberta
- Nordegg (Anglo Canadian) - Alberta
- Exshaw (Quicksilver) – Horn River Basin, NEBC

A predictable royalty regime enhances the opportunity

Pembina Cardium: Paleo-View



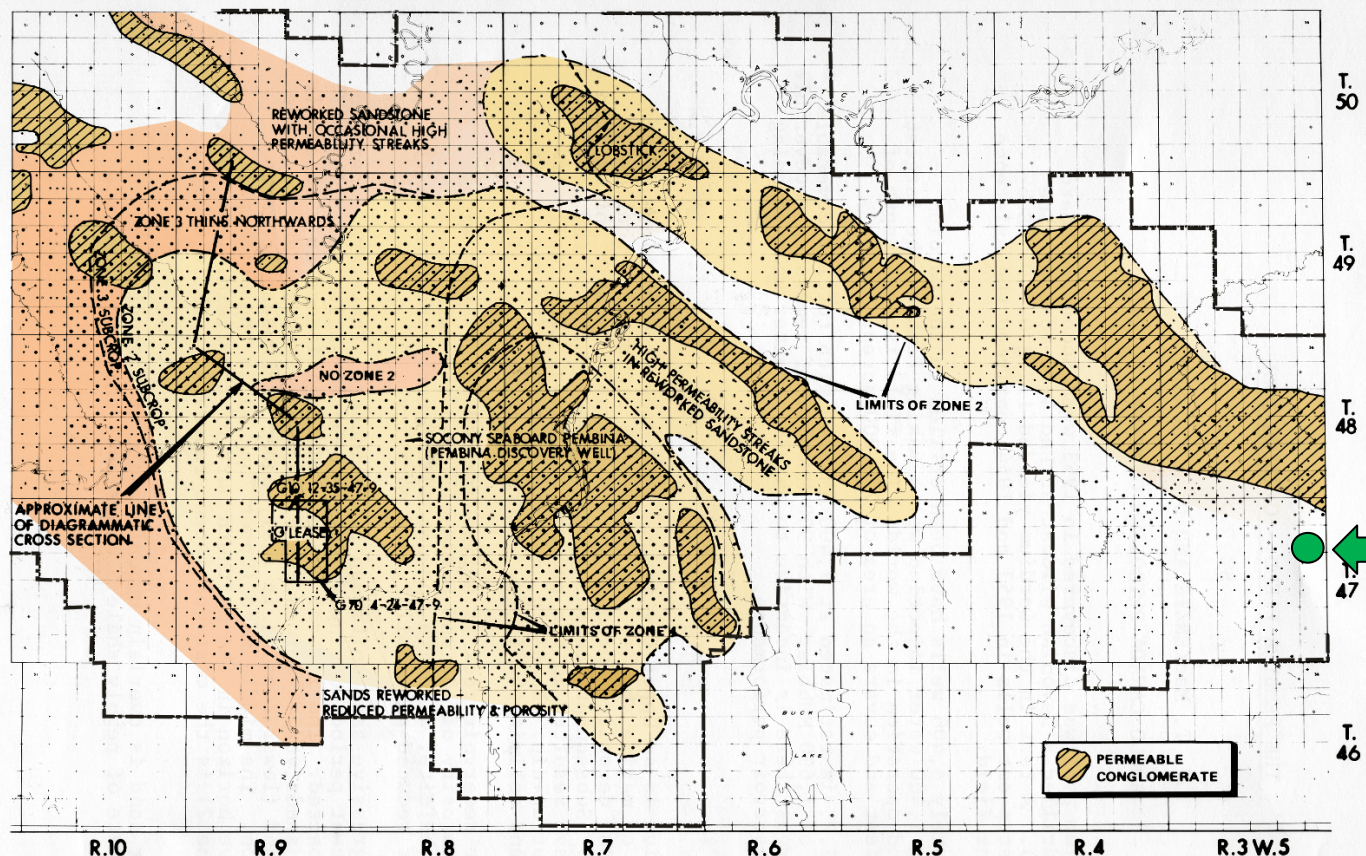
**PALEO GEOLOGY OF THE CARDIUM FORMATION
PEMBINA FIELD**
FIG. No. 1

T. 50
T. 49
T. 48
T. 47
T. 46

R.10 R.9 R.8 R.7 R.6 R.5 R.4 R.3W.5

← Bonterra 1-25-47-3W5
On prod Jan 2009,
Cum. to June 2010:
52.6mbo

Pembina Cardium: Paleo-View



Bonterra 1-25-47-3W5

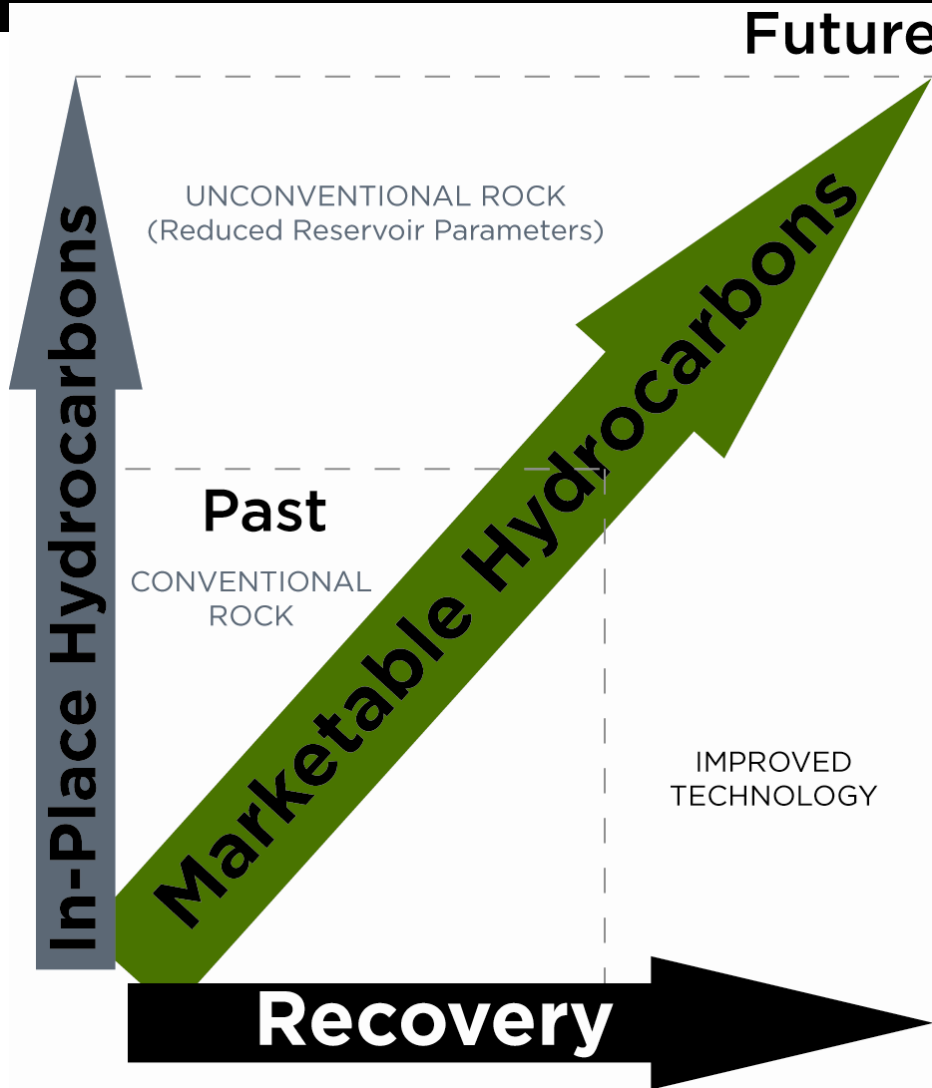
On prod Jan 2009,

Cum. to June 2010:

52.6mbo

Relationship and occurrence of sands and conglomerates vary across the Field. Understanding the geology is vital!

More oil from known reservoir rocks



Current reservoirs often have rock parameters below historical cut-offs

- In-Place hydrocarbons understated

Improved technology increases marketable hydrocarbons from both currently defined in-place hydrocarbons and adds production from previously undefined resources

The Cardium at Pembina

Better than the Bakken ?

- East Pembina 300 metres shallower than Bakken
- No free water in the Cardium to provide production surprises
- 300 metres of impermeable rock above the Cardium and 250 metres below
 - No risk of drilling or fracturing into a wet zone (except where water injected)
- Structure is relatively predictable
 - No underlying salt solution features to interfere with horizontal drilling trajectory
- Estimates of the oil in place per section higher

The Opportunity is Here and Now

- In most known conventional oil reservoirs – high percentage of oil remains unproduced
- Oil in lower quality rock is often not included in the OOIP
- The most attractive place to look for more oil is where it has already been found and produced
- Western Canada has an abundance of such opportunities
- Economic success is not just big fracs or many fracs
 - Extreme diligence and co-ordination between disciplines
 - Specific understanding of geology and rock properties

Questions?

Please contact AJM for more information

This presentation available at www.ajmpc.com



10 [Ten years of insight and analysis]