The Lower Montney Turbidite Complex of Northwest Alberta and Northeast British Columbia: Evolution of an Oil and Gas Play From Conventional to Unconventional*

Richard Sereda[1]

Search and Discovery Article #10987 (2017)**
Posted August 28, 2017

*Adapted from oral presentation given at AAPG 2017 Annual Convention and Exhibition, Houston, Texas, United States, April 2-5, 2017

[1]Leucrotta Exploration Inc, Calgary, Alberta, Canada (rdsereda@leucrotta.ca)

Abstract

The Lower Triassic Montney formation is one of western Canada's most lucrative unconventional hydrocarbon plays. With a thickness in excess of 300m, aerial extent covering approximately 130,000 km^2, the National Energy Board of Canada estimates the Montney Formation contains marketable resources of 449 TCF of gas, 14.5 billion barrels of NGL's and 1.13 billion barrels of oil. The Lower Montney Formation in the Peace River Arch region of northwest Alberta and northeast British Columbia was one of the first areas of the Montney exploited for hydrocarbon beginning in 1980. The initial discoveries were made in turbidite channel complexes, using 3D seismic and conventional vertical drilling and completion methods. The reservoir are highly porous (15%) and permeable (1-5 md) fine-grained channel sands. The channels facies is very prolific but limited in aerial extent. Beginning in 2006, with the advent of horizontal drilling and multi-frac completion technology, it now became possible to economically exploit the thicker more aerial extensive, fan portion of the turbidite complex. These rocks are fine-grained laminated siltstones with lower porosity (3-10%) and lower permeability (less than 0.1 md) but, extremely thick (30-70 m). Detailed geological mapping reveals that the deposition and the thickness of the fan are structurally controlled by underlying Paleozoic fault systems that define the Fort St. John graben complex. Isotope geochemistry of the hydrocarbons reveals that they are internally sourced, and their distribution display a normal thermal maturity distribution with dry gas being found in the deepest portion of the basin, transitioning to wet gas condensate and light oil concentrated along the basin margin. The fan can be mapped into three cycles ranging in thickness of 15m to 25m. Each cycle has a preferred landing zone, which contains more highly porous and permeable rock which local operators target. Thru time, the more proximal portion of the fan has been

exploited but with the further advancement of drilling and completion techniques, more distal portions of the fan complex are economically being exploited.

Selected Reference

Schoell, M., and J. LeFever, 2011, Carbon and Hydrogen Isotope Systematics in Gases from Horizontal Bakken Shale Wells: Search & Discovery Article #110149, Web Accessed August 12, 2017, http://www.searchanddiscovery.com/documents/2011/110149schoell/ndx_schoell.pdf

LEUCROTTA
EXPLORATION INC.

THE LOWER MONTNEY TURBIDITE COMPLEX OF NW ALBERTA AND NEBC

Evolution of an Oil & Gas Play

"From Conventional to Unconventional"

Richard Sereda MSc. P. Geol.
Sr. VP. Exploration Leucrotta Exploration Inc.

AAPG Annual Convention
April 2017

Forward Looking Information

LXE-T www.Leucrotta.ca

This document contains forward-looking statements and forward-looking information within the meaning of applicable securities laws. The use of any of the words “expect”, “anticipate”, “continue”, “estimate”, “may”, “will”, “should”, “believe”, “intends”, “forecast”, “plans”, “guidance” and similar expressions are intended to identify forward-looking statements or information.

More particularly and without limitation, this document contains forward looking statements and information relating to the Company’s risk management program, oil, NGLs and natural gas production, capital programs, oil, NGLs, and natural gas commodity prices, and debt levels. The forward-looking statements and information are based on certain key expectations and assumptions made by the Company, including expectations and assumptions relating to prevailing commodity prices and exchange rates, applicable royalty rates and tax laws, future well production rates, the performance of existing wells, the success of drilling new wells, the availability of capital to undertake planned activities and the availability and cost of labor and services.

Although the Company believes that the expectations reflected in such forward-looking statements and information are reasonable, it can give no assurance that such expectations will prove to be correct. Since forward-looking statements and information address future events and conditions, by their very nature they involve inherent risks and uncertainties. Actual results may differ materially from those currently anticipated due to a number of factors and risks. These include, but are not limited to, the risks associated with the oil and gas industry in general such as operational risks in development, exploration and production, delays or changes in plans with respect to exploration or development projects or capital expenditures, the uncertainty of estimates and projections relating to production rates, costs and expenses, commodity price and exchange rate fluctuations, marketing and transportation, environmental risks, competition, the ability to access sufficient capital from internal and external sources and changes in tax, royalty and environmental legislation. The forward-looking statements and information contained in this document are made as of the date hereof for the purpose of providing the readers with the Company’s expectations for the coming year. The forward-looking statements and information may not be appropriate for other purposes. The Company undertakes no obligation to update publicly or revise any forward-looking statements or information, whether as a result of new information, future events or otherwise, unless so required by applicable securities laws.

Montney
"World Class Resource Play"

Large Areal Extent & Thickness:

- Extends over 50,000 sq. miles.
- Stacked resource up to 1000 ft. thick

Massive Resource Potential:

- *Over 450 Tcf gas , 14.5 Bbbls Ngl's and 1.2 Bbbls of oil (marketable). "NEB 2013"*

"Fracability":

- Low clay content, low Poisson's ratio and high Young's Modules.

High Permeability:

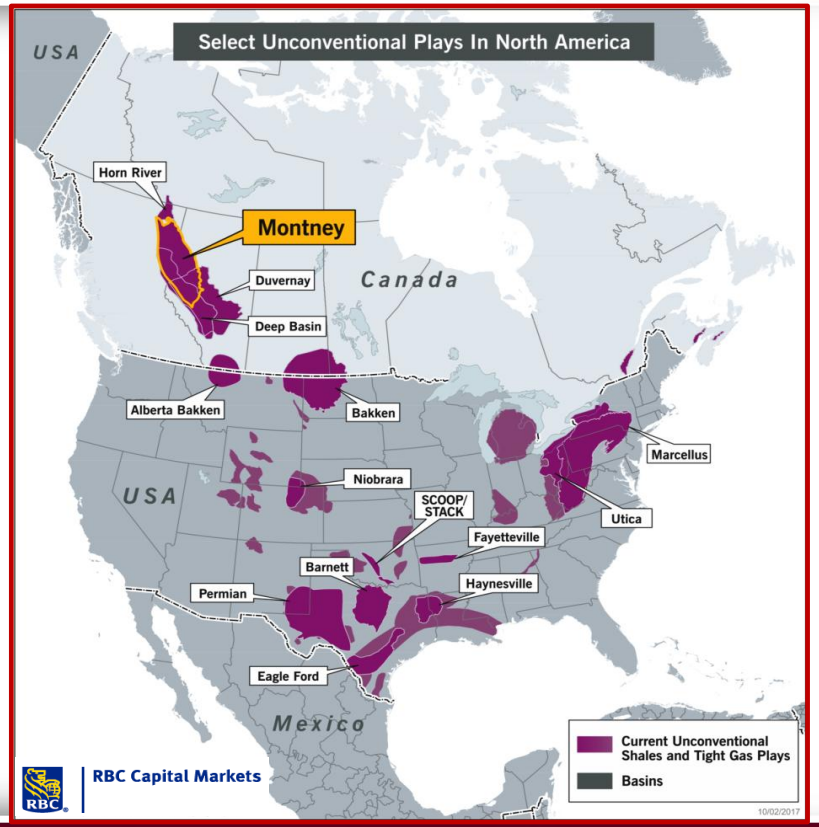
- Siltstone not a shale.

Over Pressured:

- Up to 2 times normal pressure

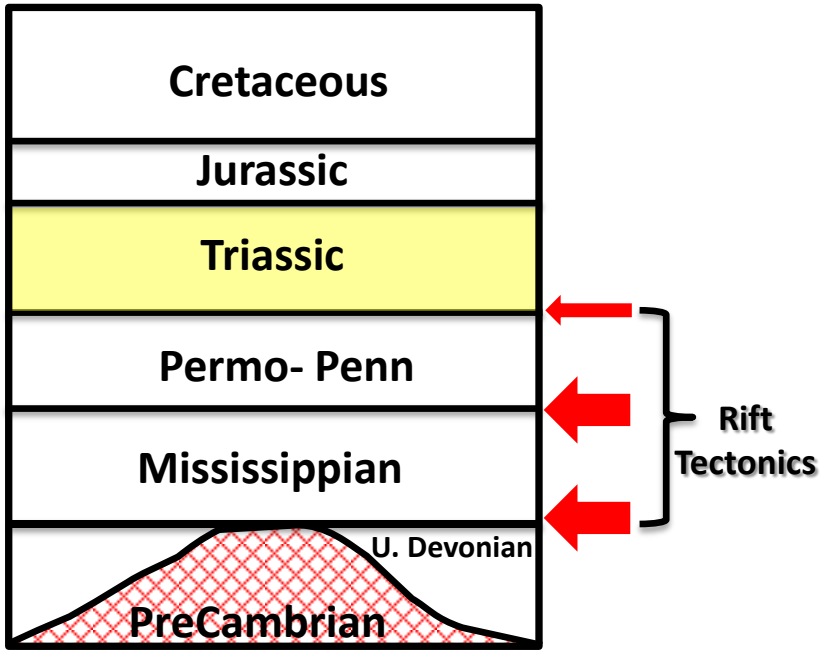
Competitive Land Tenure and Royalty:

- 5-20% royalty for life of well
- Multi-section licenses and leases continued by 1 well

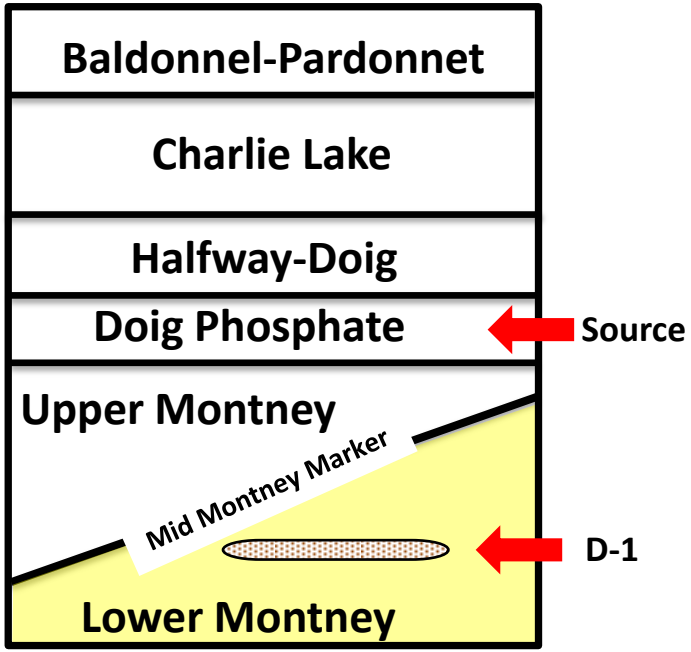


Peace River Arch Stratigraphy

PRA Strat Column



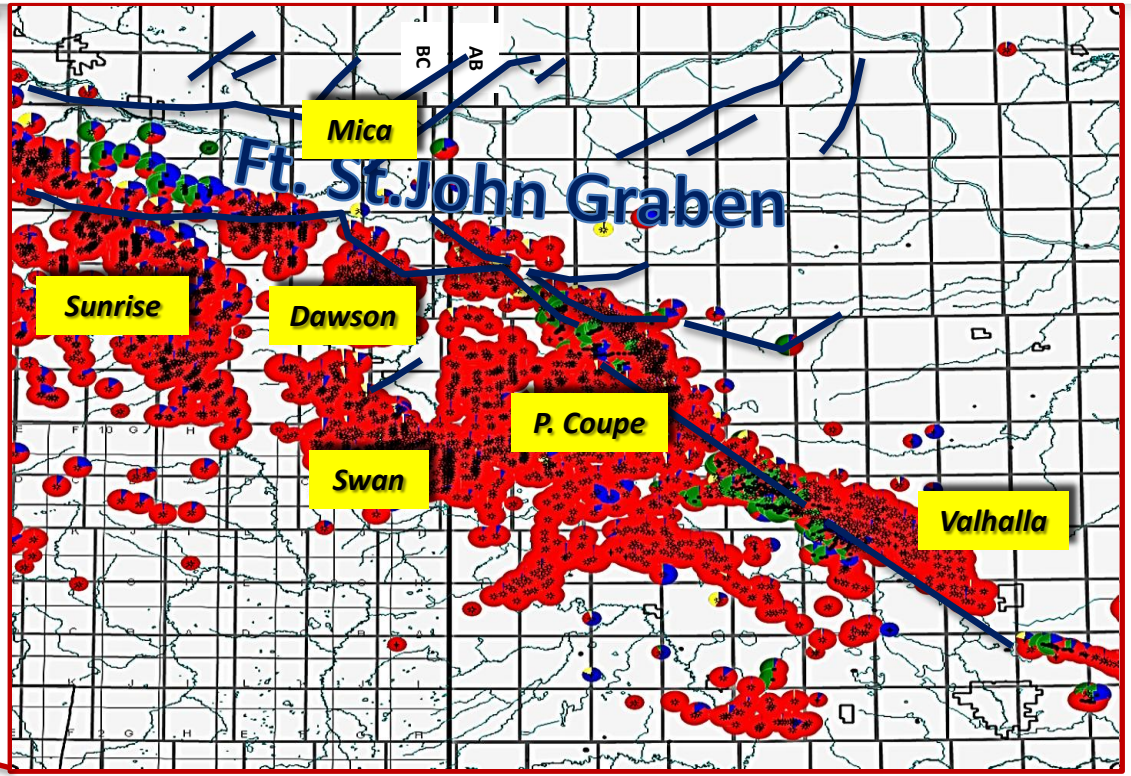
Triassic Strat Column



LEUCROTTA EXPLORATION INC.

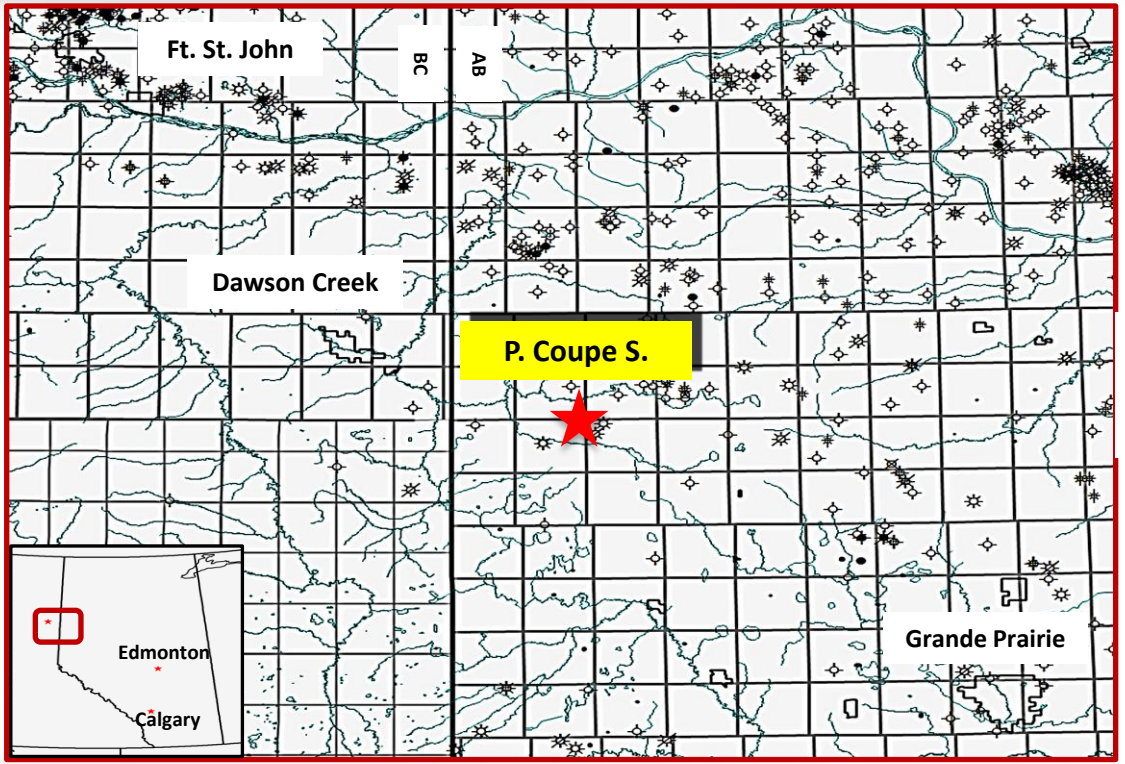
Area of Investigation

10,000 miles sq^2

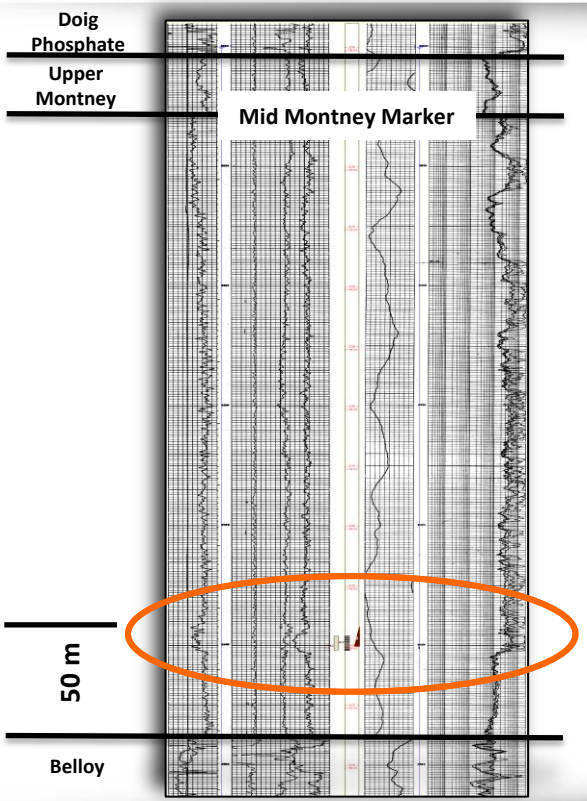


Area Penetrations prior 1980

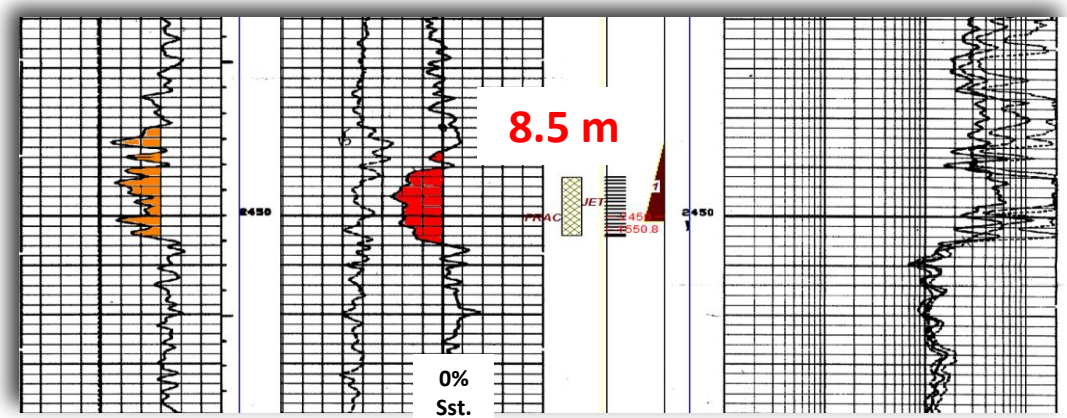
- ***Lightly explored at the Montney Level prior to 1980***
- ***A few wells in the Pouce Coupe area had penetrated the reservoir but were not tested***
- ***Discovery well, 6-32, drilled by Dome Petroleum in 1980 after intersecting the reservoir a year earlier at 7-30 while drilling deeper target.***



Lower Montney Discovery Well



Dome Petroleum
6-32-76-11W6M
RR. Nov. 8/1980



IP. 30 1.65 mmcf/d
Cumulative Production Jan 1992-Pres.
Gas 5.9 bcf
Oil 655 bbls

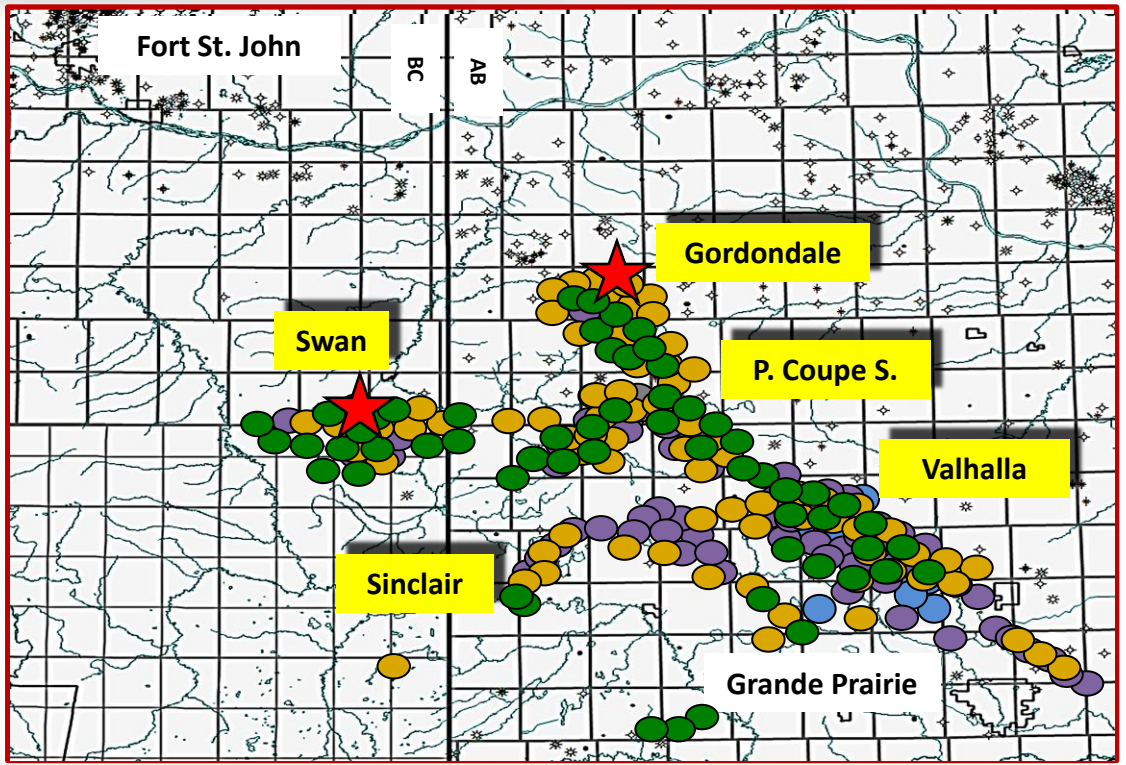
LEUCROTTA EXPLORATION INC.

Industry Activity 1980-2009
"The Conventional Era"

- ***1980-1986***
- ***1987-1992***
- ***1993-1998***
- ***1999-2004***
- ***2005-2009***

Encana drills first Hz's in 2006

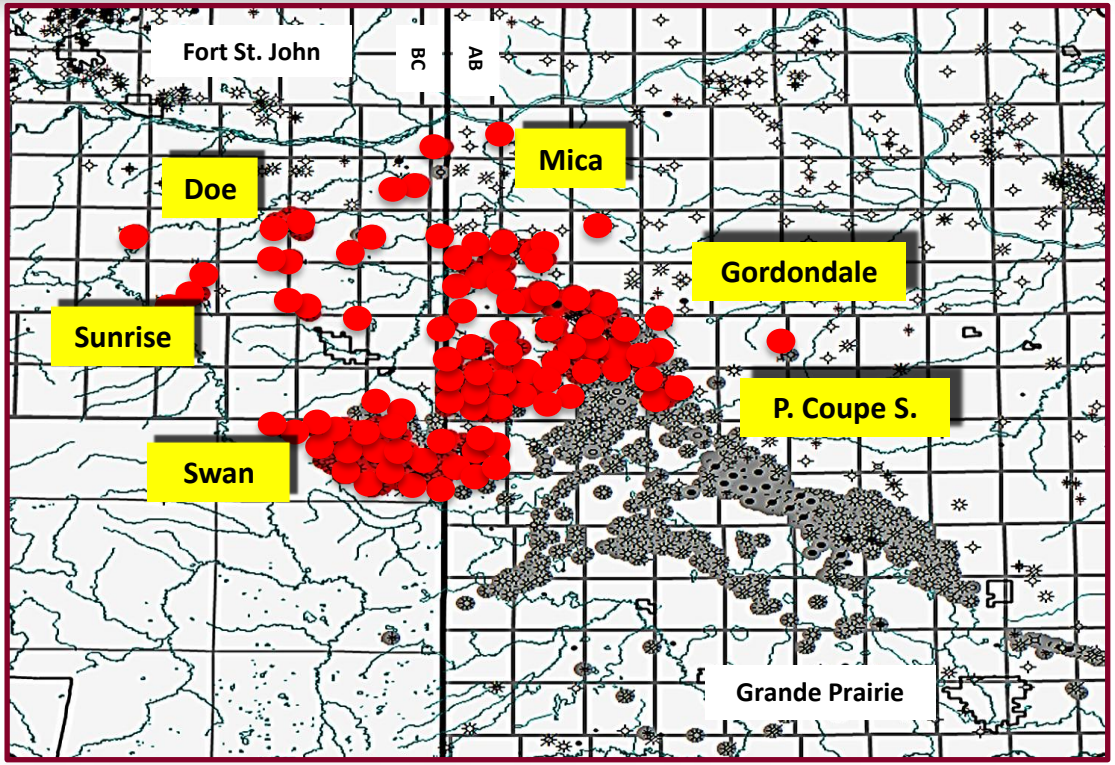
- ***Swan 1100 m 6-stage Hz multi-frac.***
- ***Gordondale 1200 m 4- stage Hz-multi frac.***



LEUCROTTA EXPLORATION INC.

Industry Activity 2007 – 2016
The Unconventional Era

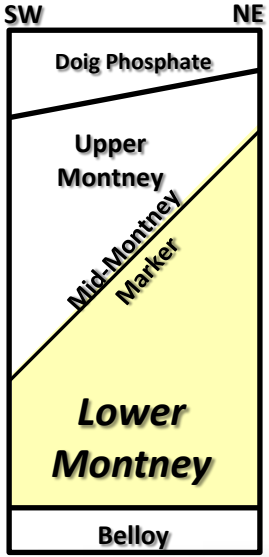
- ***1980 – 2009 Verticals***
- ***2008 – 2016 Horizontals***

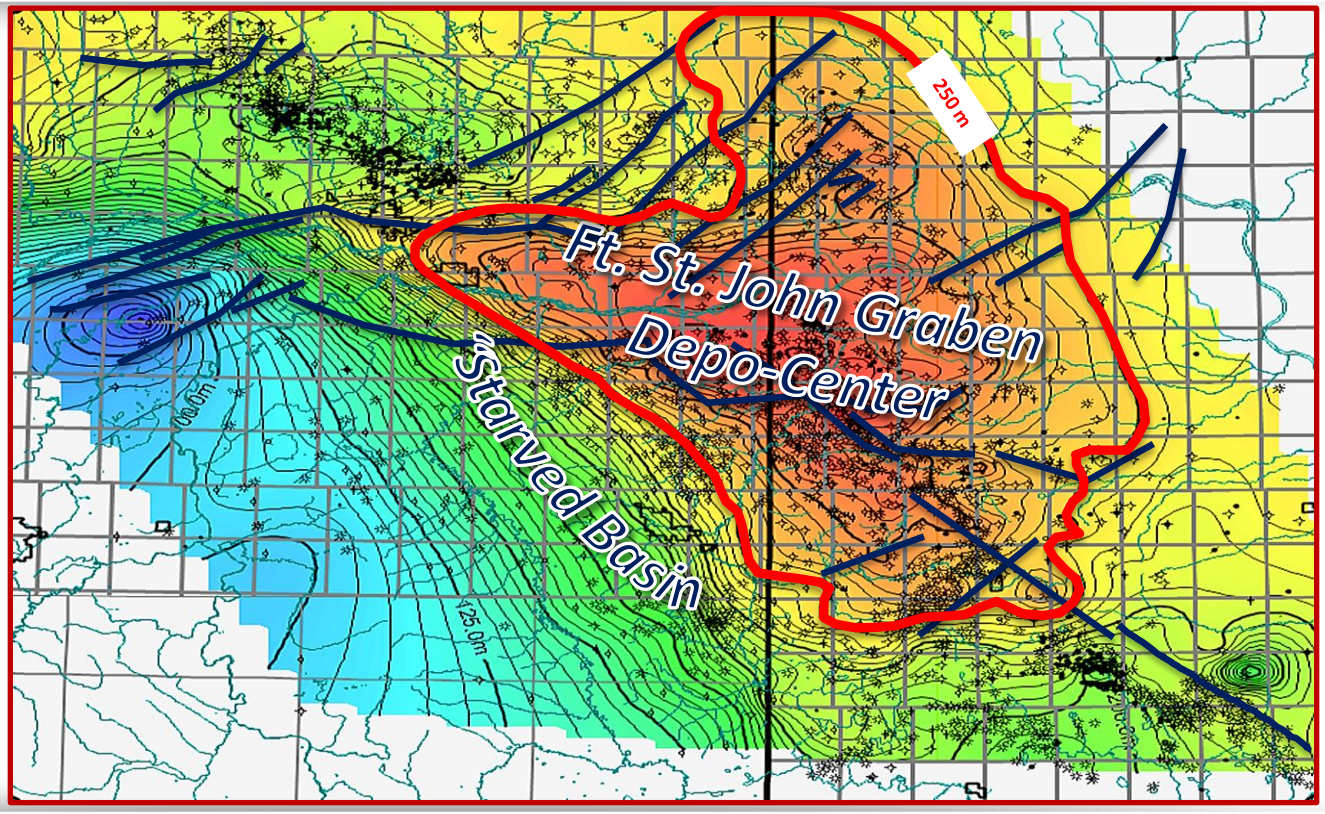


LEUCROTTA EXPLORATION INC.

Lower Montney Basin Geometry

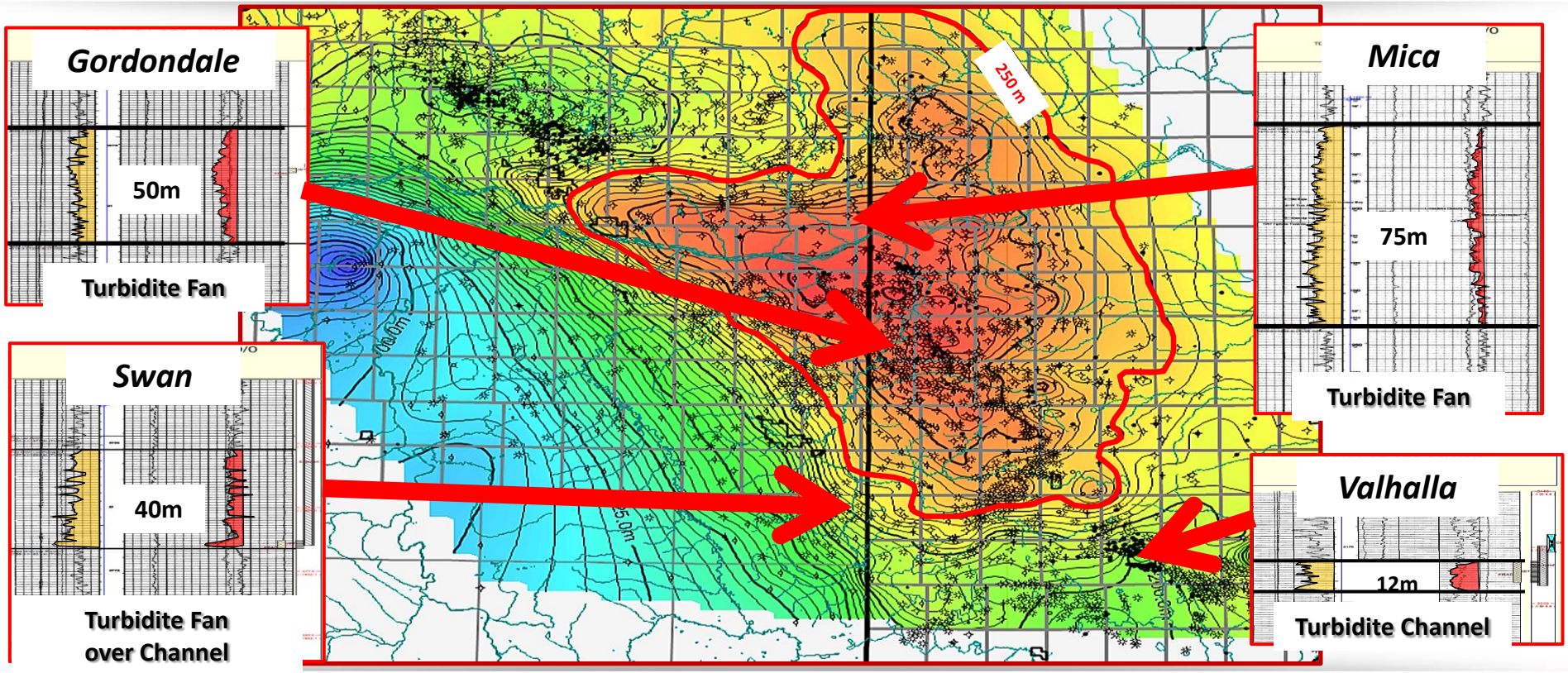
Isopach
Mid Montney Marker
to Permian Belloy





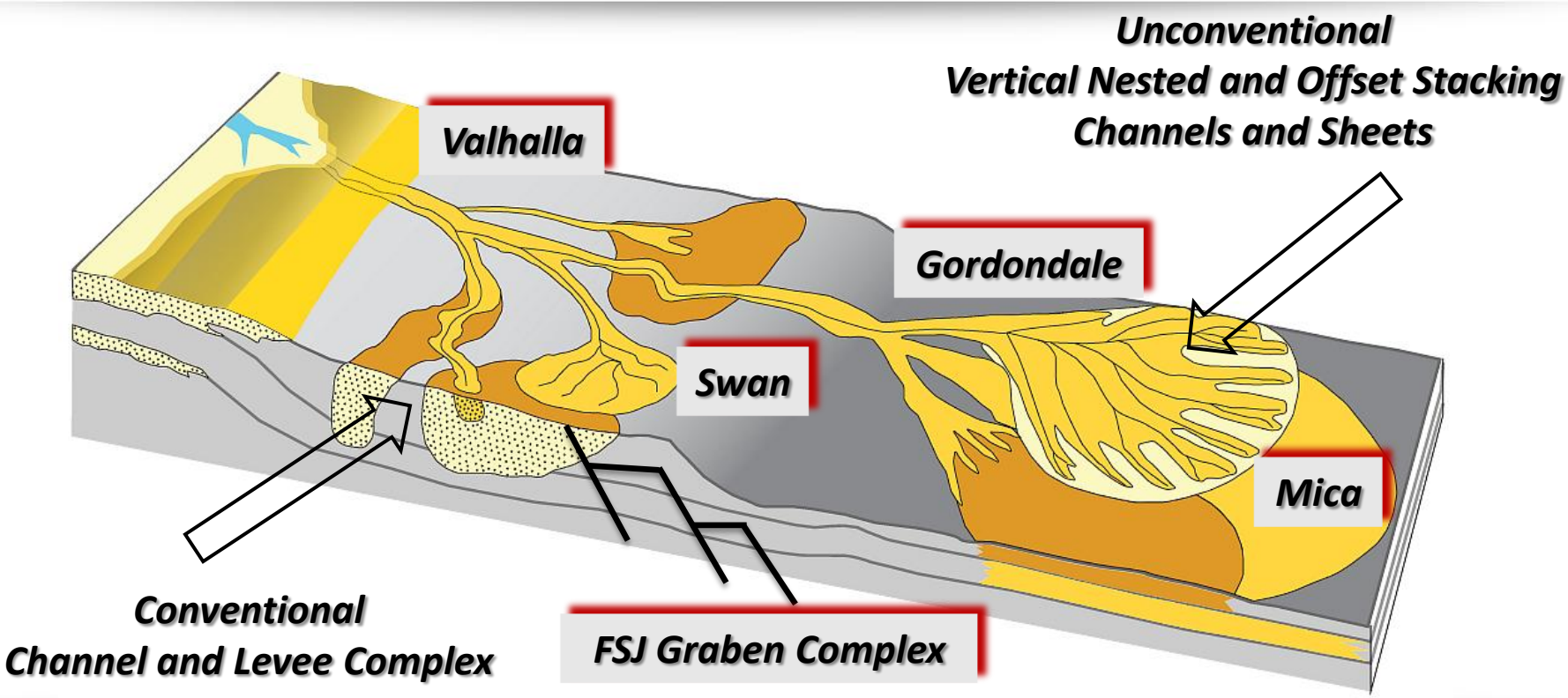
LEUCROTTA EXPLORATION INC.

Lower Montney (D1) Log Facies



LEUCROTTA EXPLORATION INC.

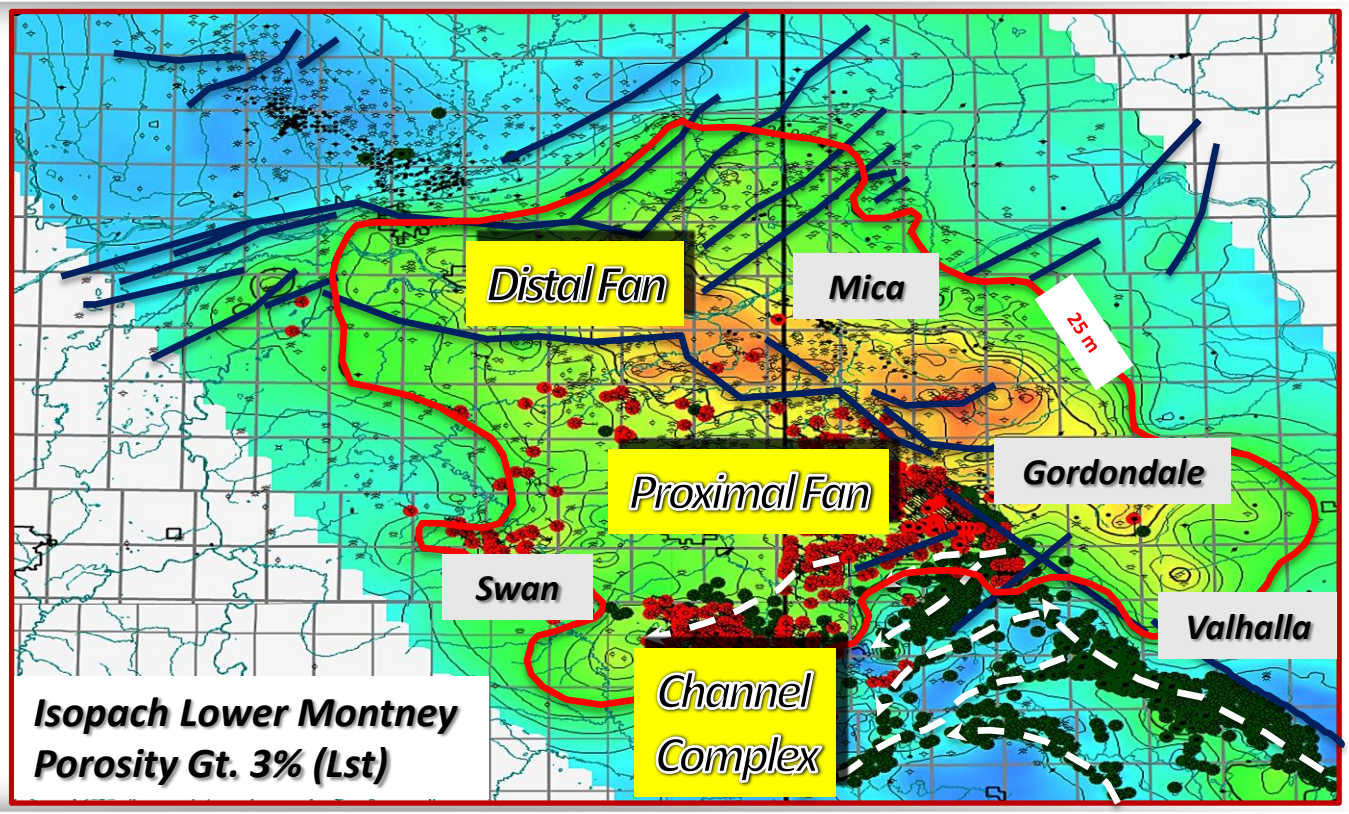
Lower Montney Depositional Model (modified from Kendall 2012)



LEUCROTTA EXPLORATION INC.

Lower Montney
Turbidite Channel – Fan Complex

- ***Verticals wells dominate the channel complex.***
- ***Hz wells dominate proximal to distal fan.***



Leucrotta *"Places The Bet"*

2010-2012

LXE Drill, core and

- *Sunri*

NO CONDENSATE

- *4-19-80-14W6*
  - *211 mcf/d*

Dec 2013

LXE Doe

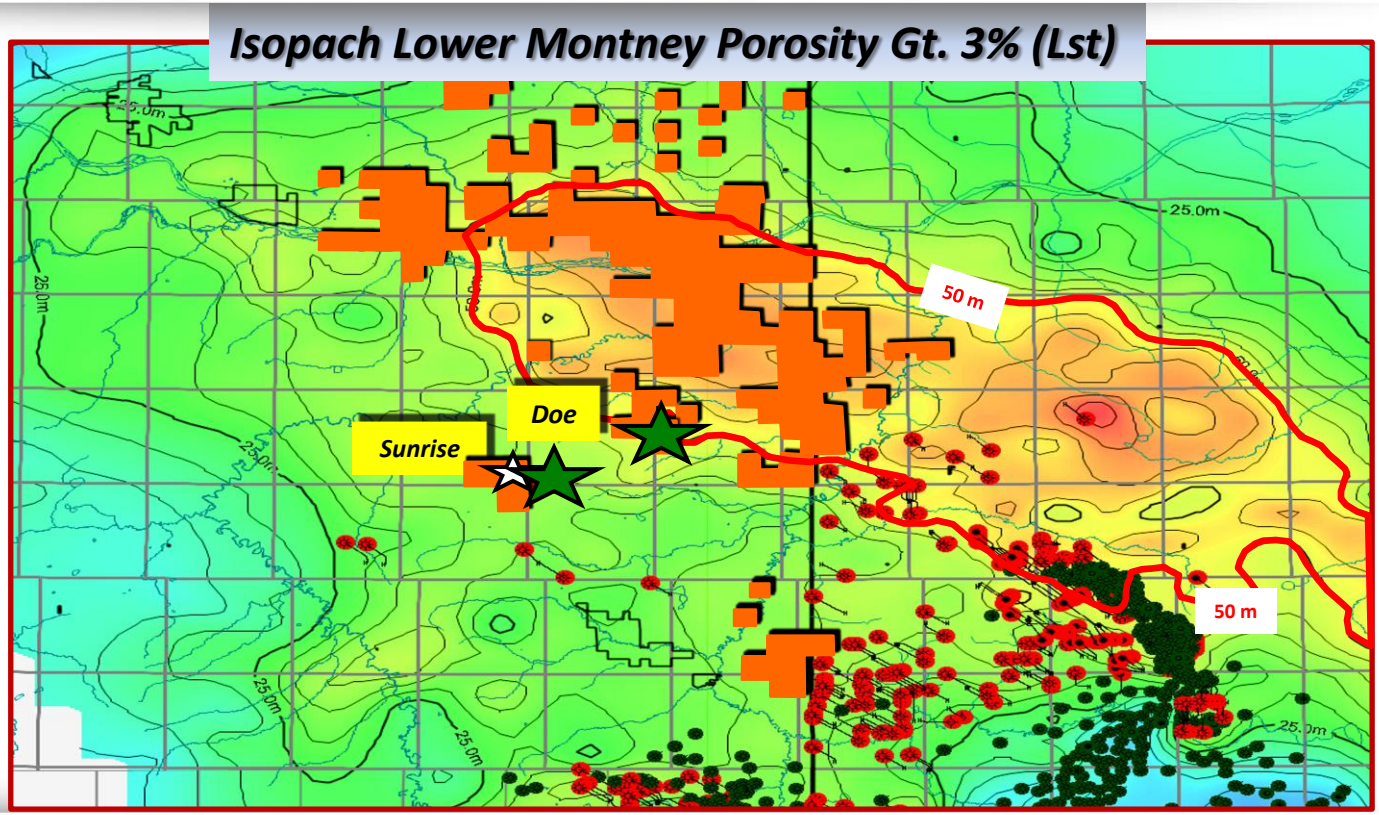
- *B4-19 IP30 4.0 mmcf/d & 234 b/d Cond.*

TOU Sunrise

- *A5-5 IP30 6.3 mmc/d & 634b/d Cond.*
- *D5-5 IP30 5.6 mmcf/d & 525 b/d Cond.*

2014 – 2015

LXE adds 150 net sections Montney rights in the thick portion of the fan.

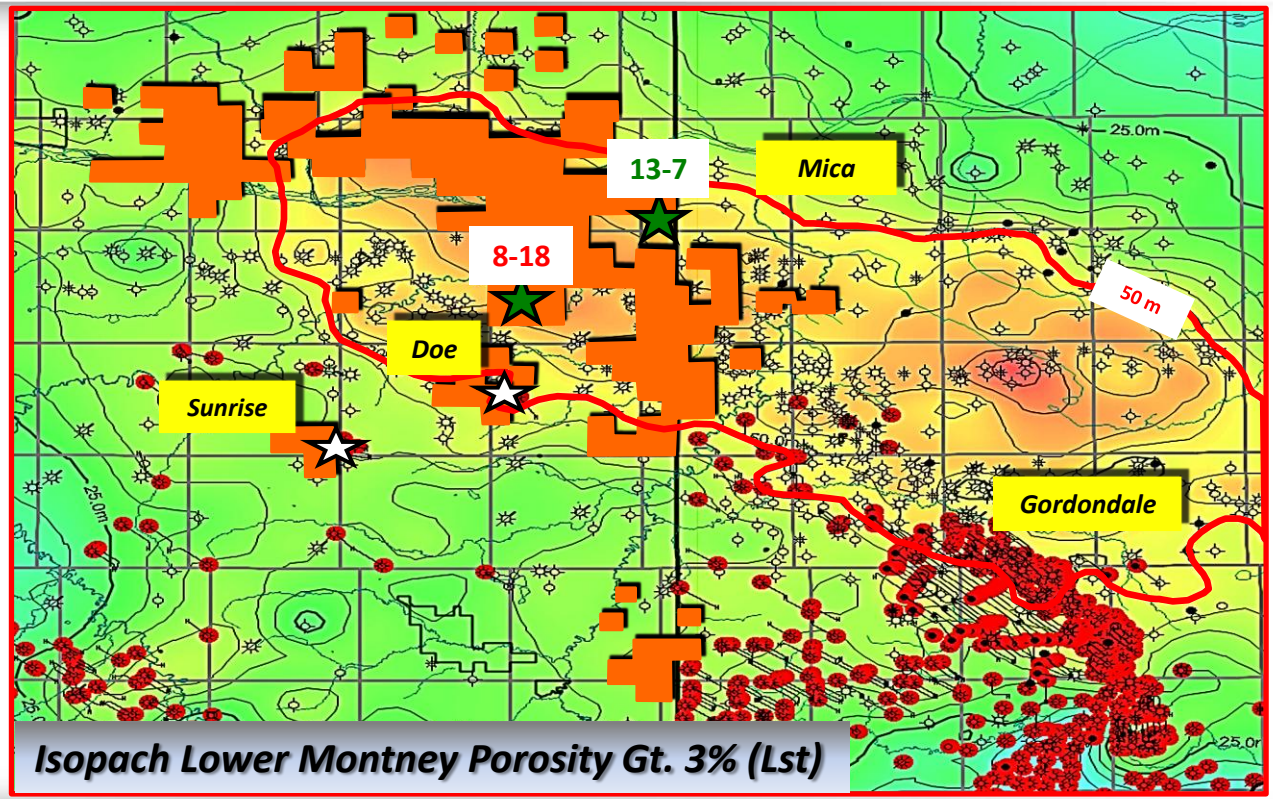


Delineating the Fan
Round 1

Two expl. wells Q4/2014

- ***13-7 30 day test 270 b/d oil & Ngls and 1.5 mmcf/d .***
- ***8-18 30 day test 150 b/d oil & Ngl's and 1.7 mmcf/d gas.***

Re-examine to understand test rates compared to the 5-5 & b4-19 and the extent of the oil at 13-7.



Isopach Lower Montney Porosity Gt. 3% (Lst)

Analytical Approach to Better Predict Outcomes

Part One

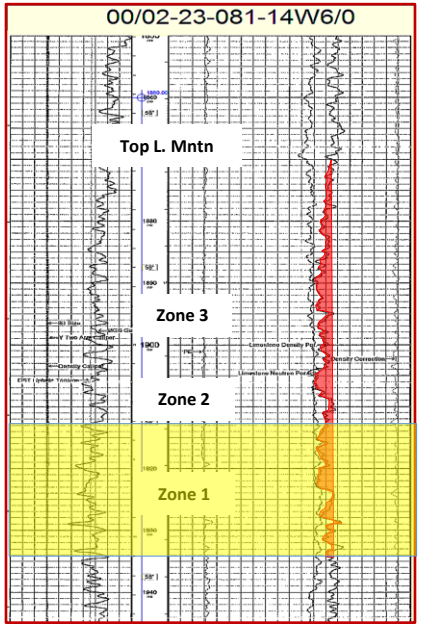
- ***Density Log Normalization***
  - ***Vertical log data set consist of a wide variety of logging companies and vintage of density logs that needed to be "normalized".***
  - ***More 'Art" than "Science".***
  - ***Identify specific stratigraphic mappable log packages that have preferential higher zones of porosity and permeability to target landing zones.***

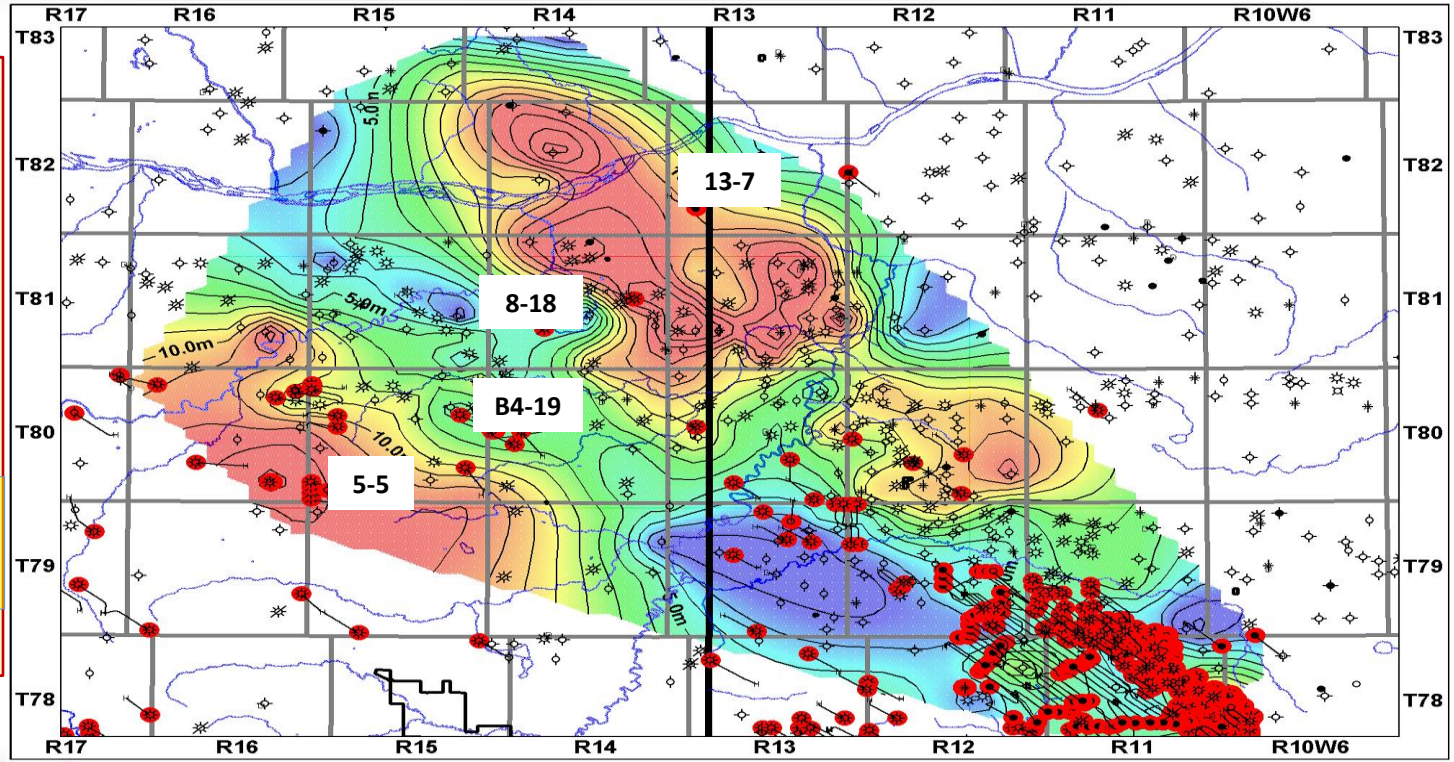
Lower Montney Zone 1

Isopach Net Porosity GT 5%

LEUCROTTA EXPLORATION INC.

Type Log



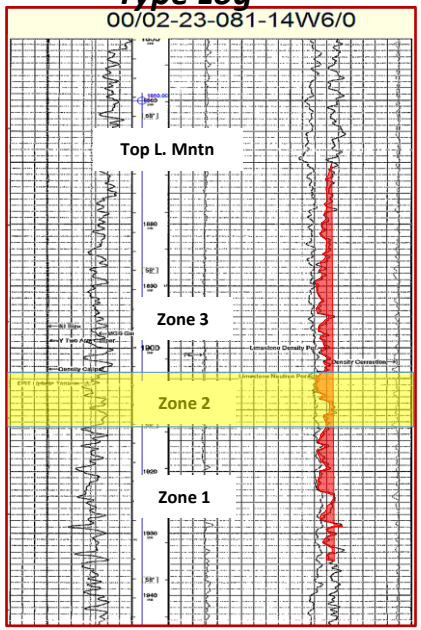


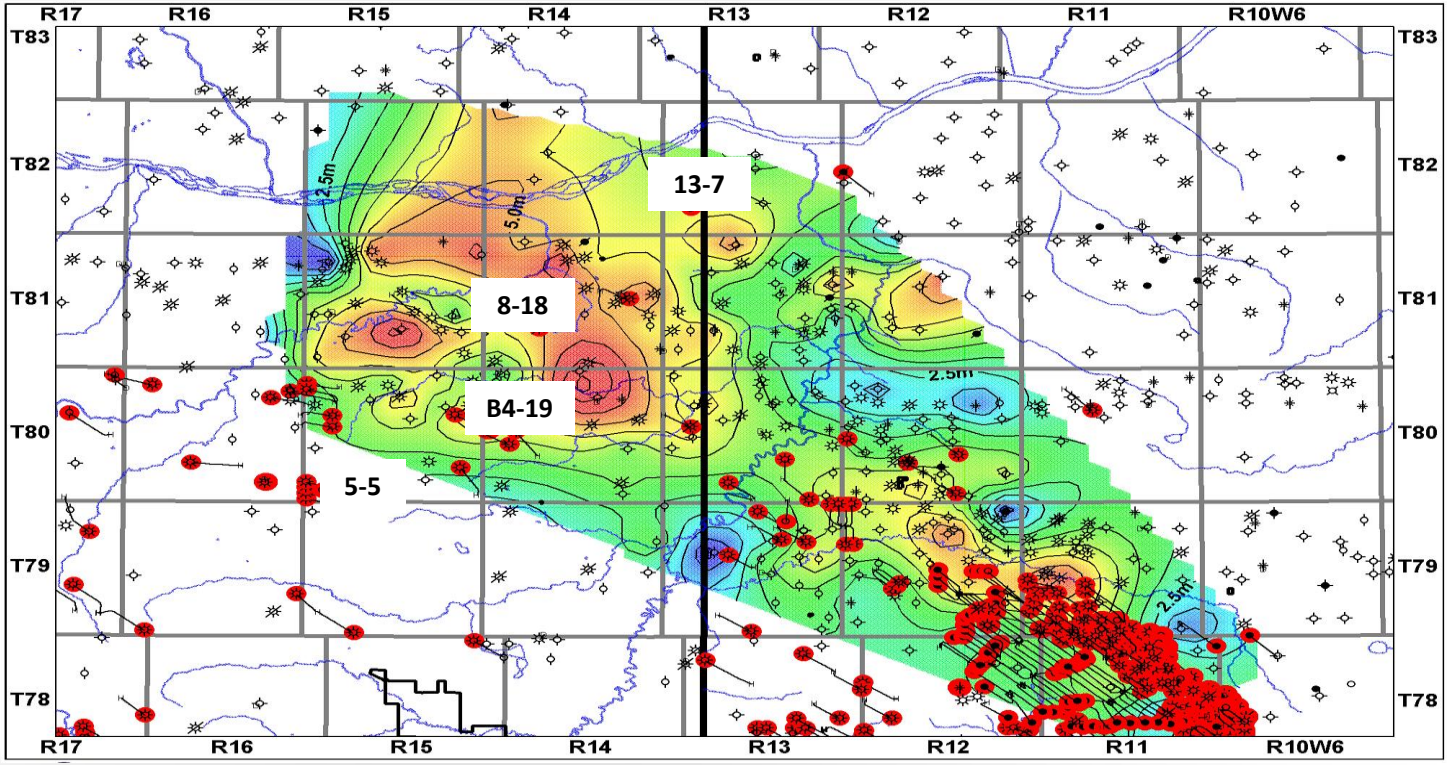
LEUCROTTA EXPLORATION INC.

Lower Montney Zone 2

Isopach Net Porosity GT 5%

Type Log



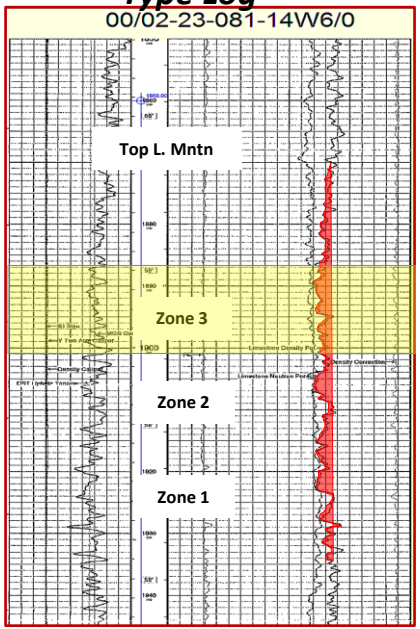


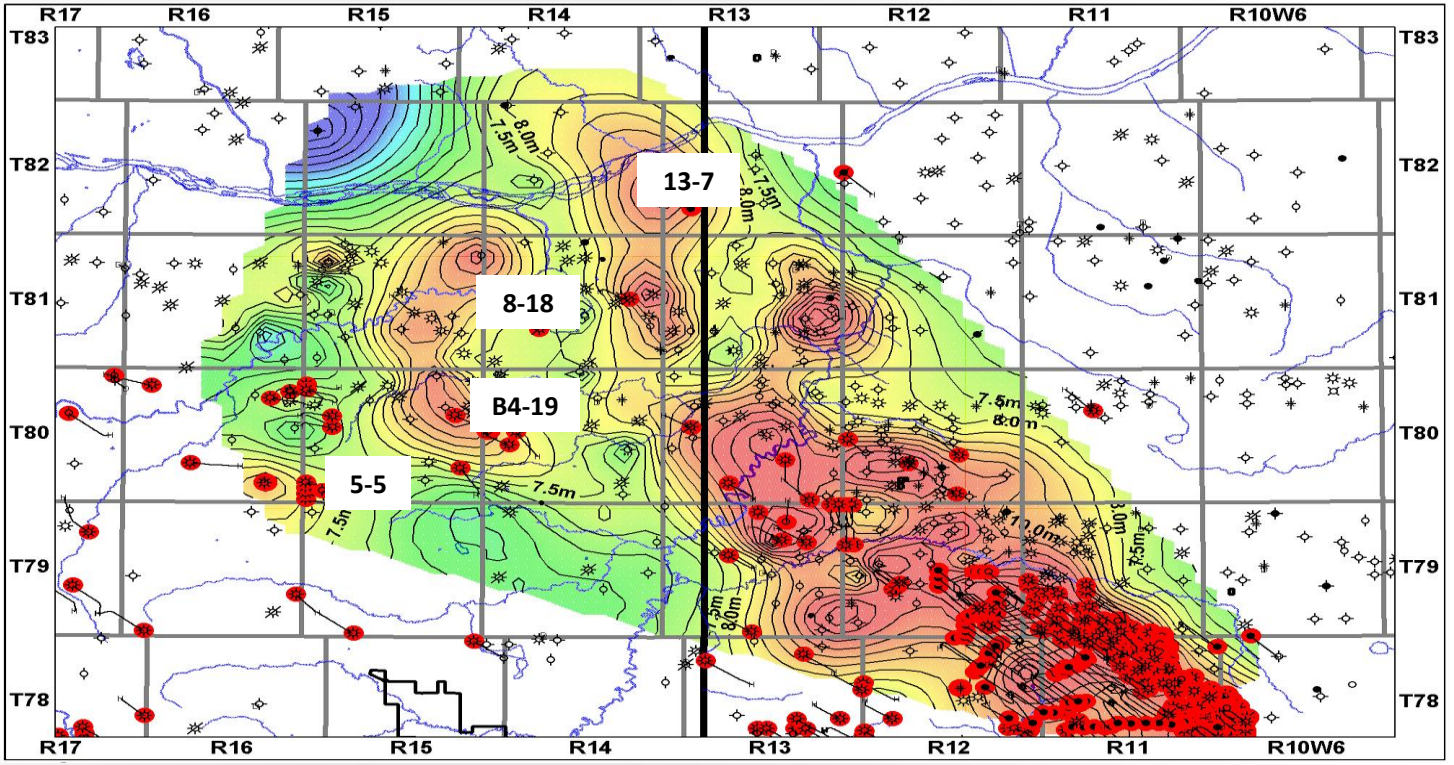
LEUCROTTA EXPLORATION INC.

Lower Montney Zone 3

Isopach Net Porosity GT 5%

Type Log

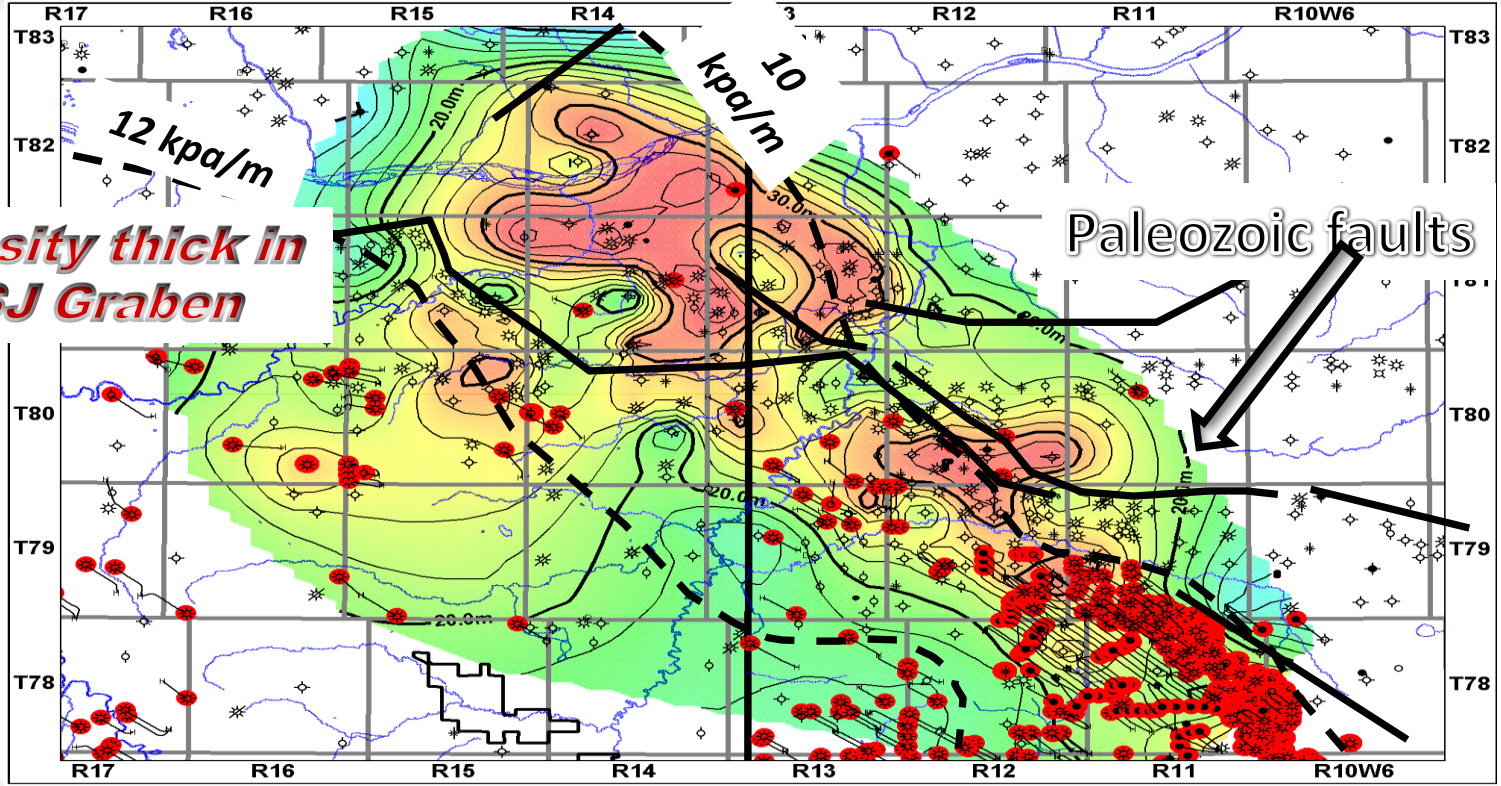




LEUCROTTA EXPLORATION INC.

Lower Montney Zone 1 thru 3

Isopach Net Porosity GT 5%



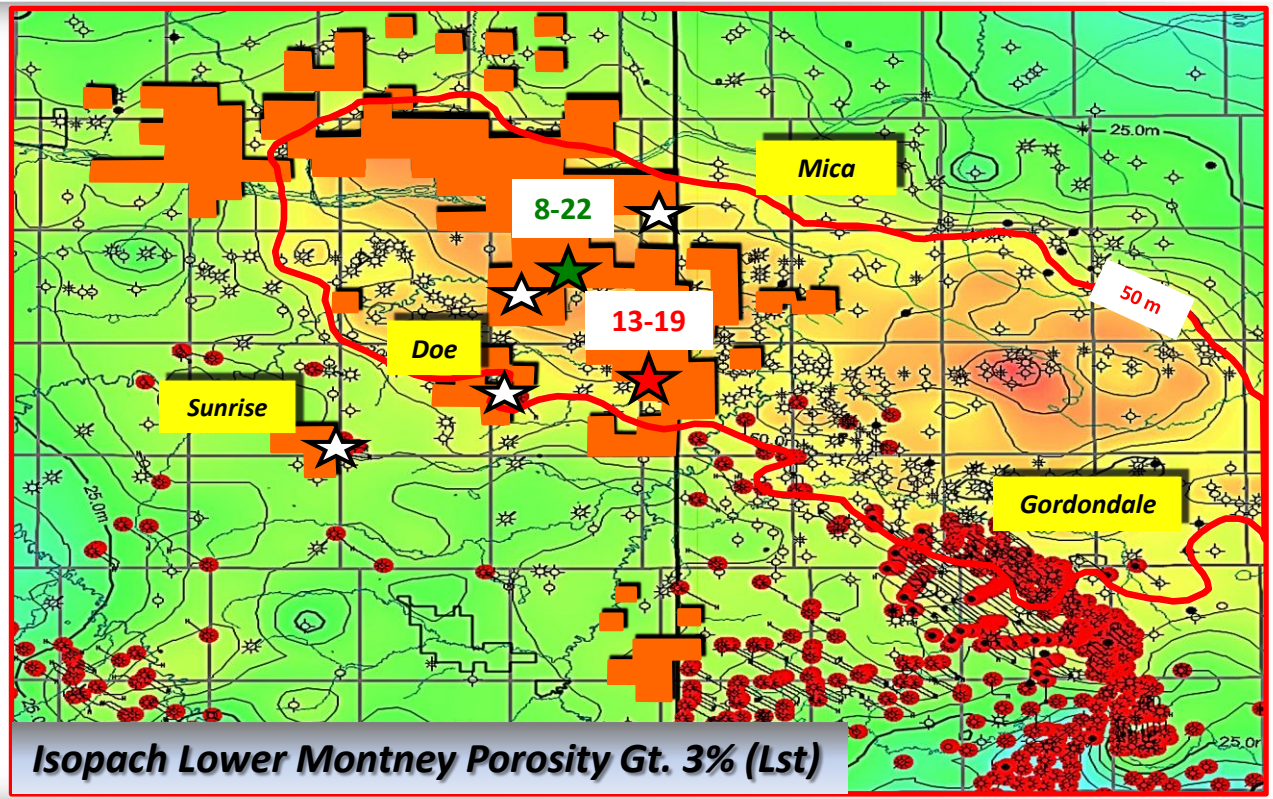
LEUCROTTA EXPLORATION INC.

Delineating the Fan Round 2

Two more exploration wells were drilled in the Q4/2015

- ***8-22 8 day test 355b/d oil & Ngls and 2.2 mmcf/d .***
- ***13-19 3 day test of 6.8 mmcf/d gas and 179 b/d free cond.***
- ***The D&C costs below $4 MM***

The size of the oil window expanded 6 miles to the SW. The Position of the landing of the well significantly increased the productivity of the wells.



Isopach Lower Montney Porosity Gt. 3% (Lst)

LEUCROTTA EXPLORATION INC.

Analytical Approach to Better Predict Outcomes

Part Two

Better Predict the Composition of the Reservoir Fluid

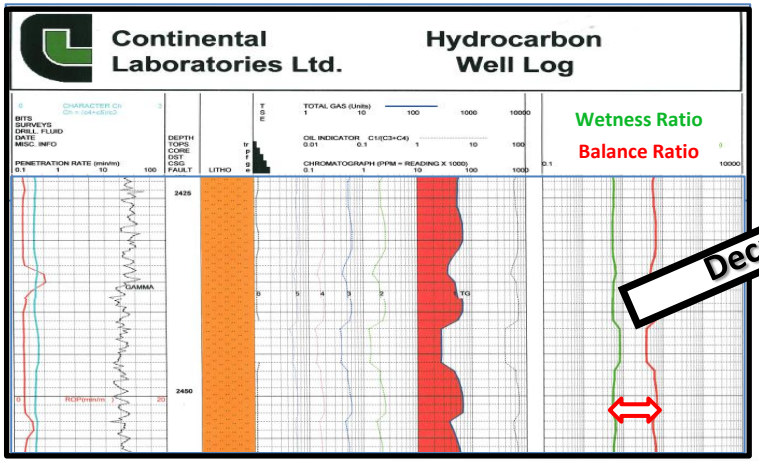
- ***Mud Gas Chromatography***
  - *Collected and interpreted before the production string is placed in the ground.*
  - *"CHEAP" Tried and true but only gives you a relative wetness.*
  - *When calibrated it will accurately predict if "Rich Gas" vs "Hi GOR Oil"*
- ***Mud Gas and Produced Gas Carbon Isotope Analysis***
  - *"Cheap" It will give you a VRE of your gas before the well is completed.*
  - *When calibrated to produced gas it can predict your gas composition and oil API before the well is completed.*
- ***Oil Typing***
  - *Are the hydrocarbons locally – internally sourced or the result of long distant migration from down-dip or from deeper horizons thru faults and fractures.*

Mud Gas Chromatography

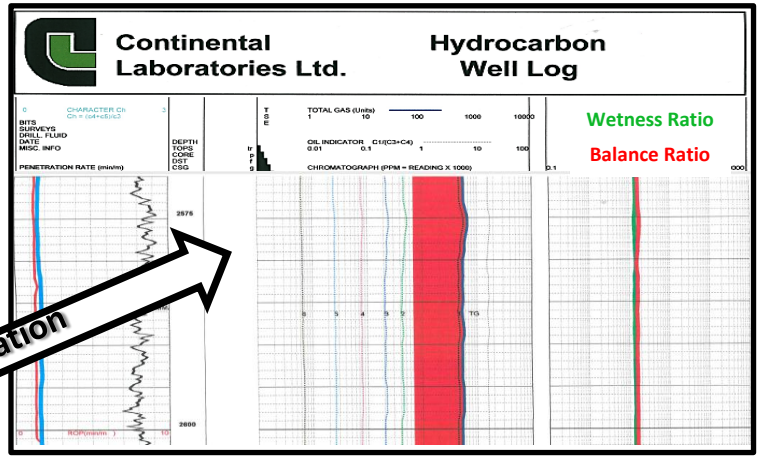
Wetness Ratio = C2-C5/C1-C5*100

Balance Ratio = C1-C2/C3-C5

Rich Gas - Condensate



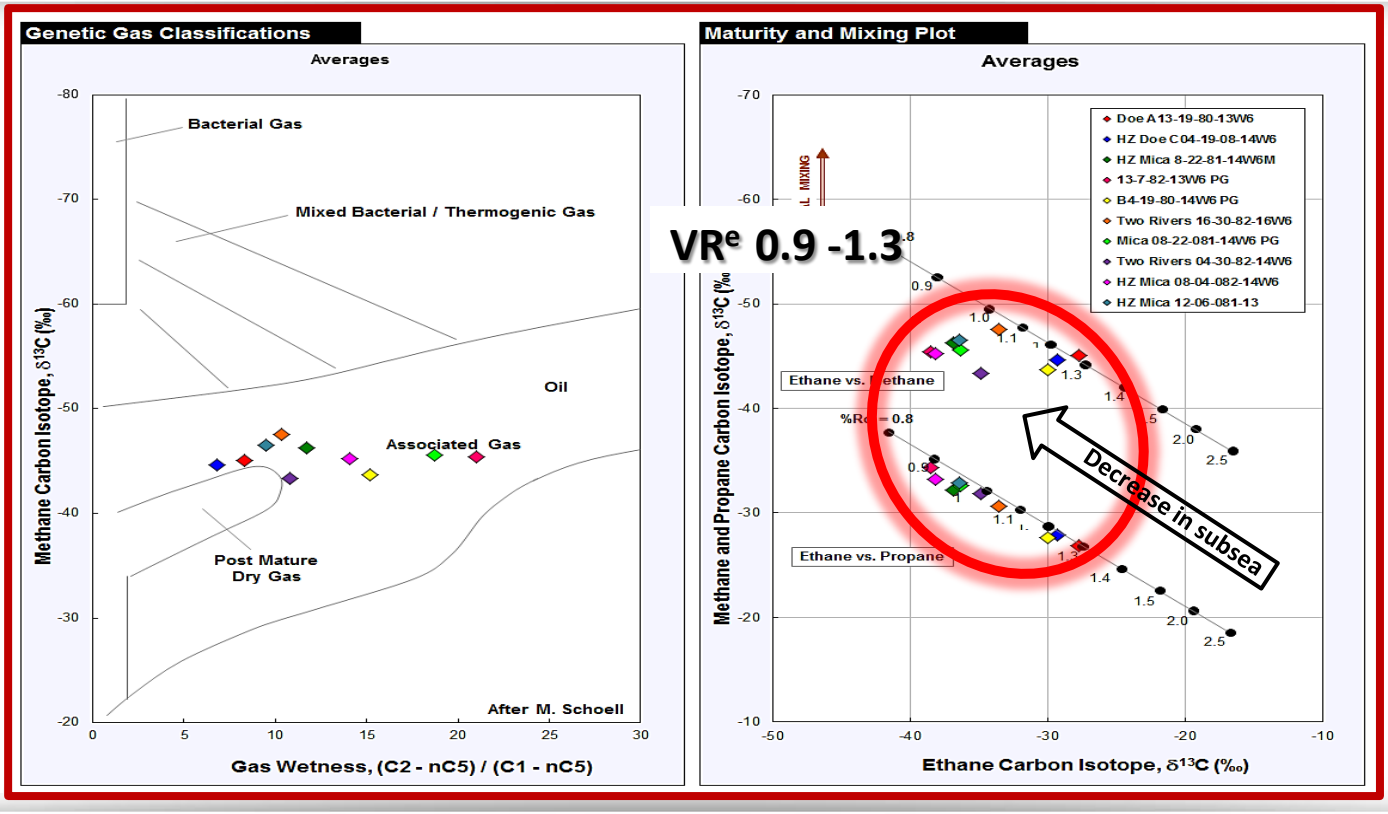
Hi GOR Oil



Decrease Subsea Elevation

**** Maintain constant MW & ROP****

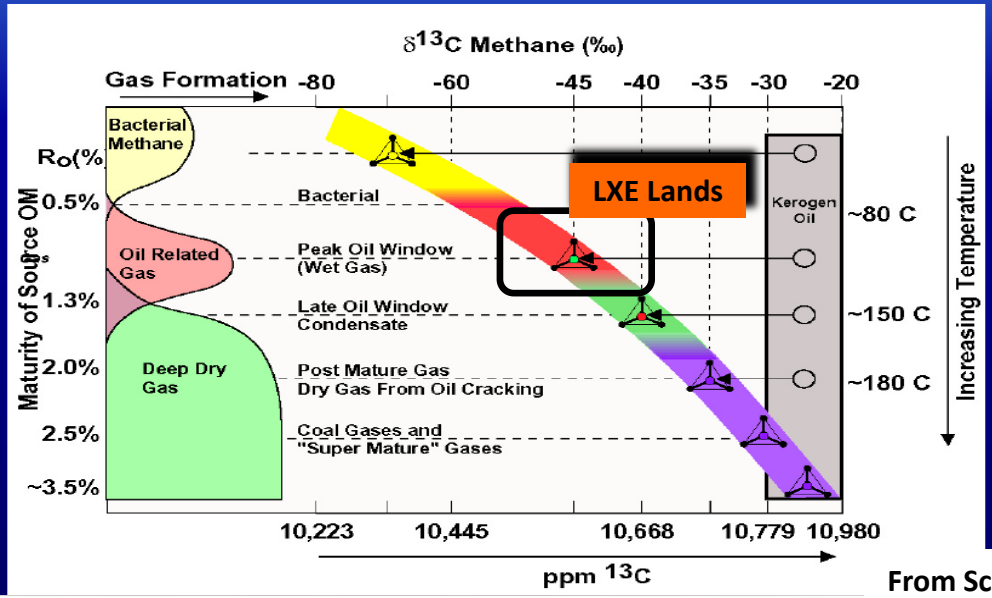
Gas Isotope Geochemistry



LEUCROTTA EXPLORATION INC.

Gas Isotope Geochemistry

Carbon Isotopes in Gases
are driven by temperature
as are processes of oil and gas formation



From Schoell and LeFever, 2011

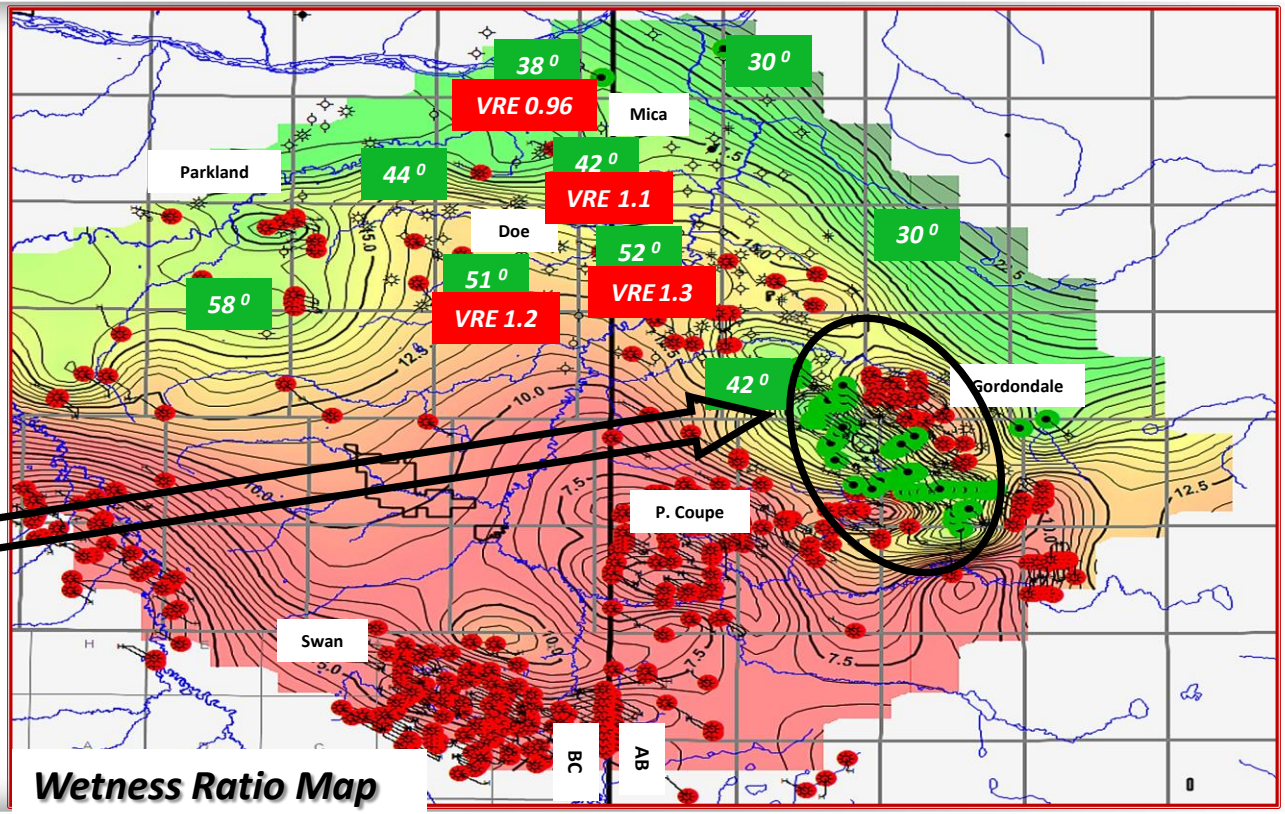
LEUCROTTA EXPLORATION INC.

Lower Montney

Displays a Normal Maturation Profile

- ***Dry Gas in the SW to Rich Gas Cond & Light Oil to the NE***
- ***High API free liquids in the SW to Lower API oils in the NE.***
- ***Mud Gas VRE 1.3 in SW to 0.96 in the NW.***

Gordondale Anomaly!

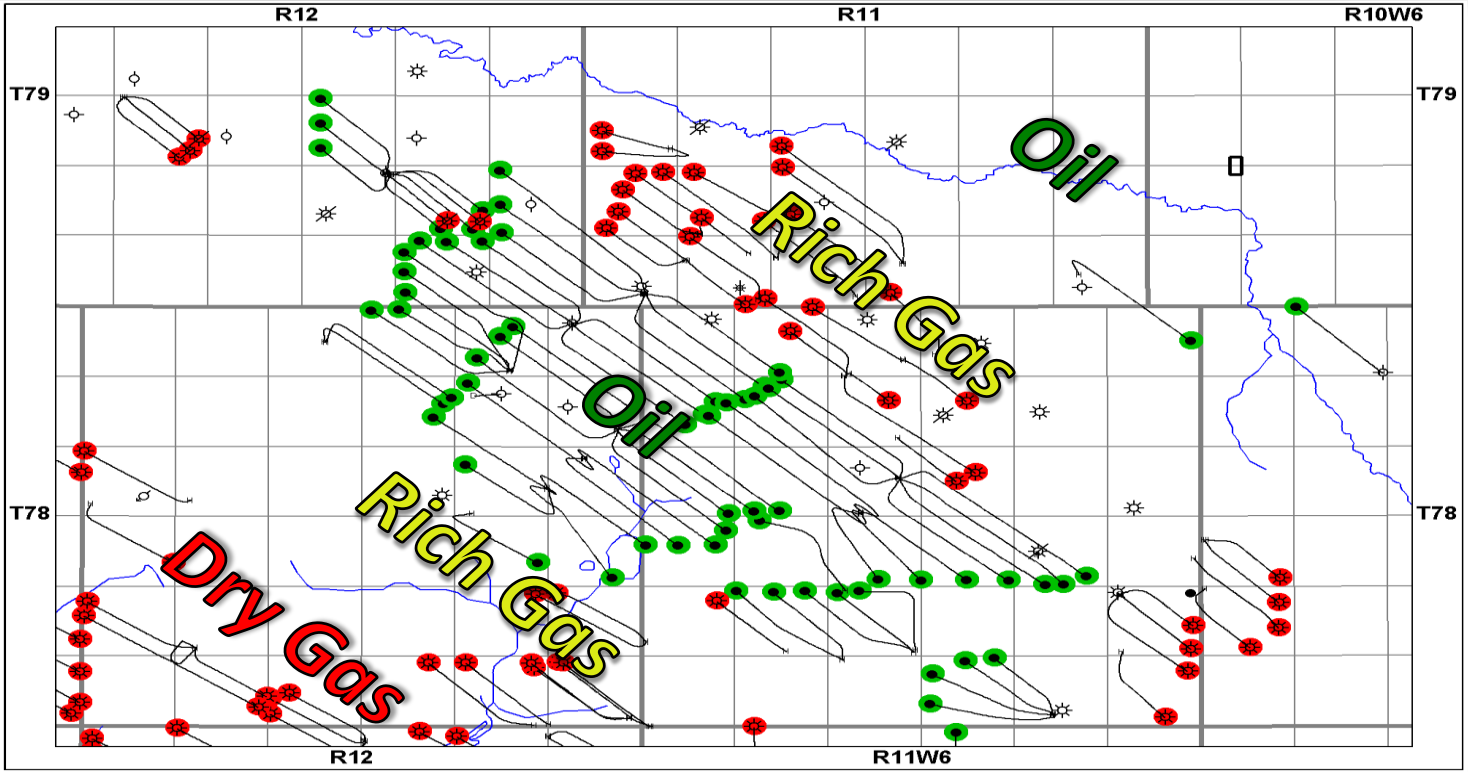


Wetness Ratio Map

LEUCROTTA EXPLORATION INC.

Gordondale

What is Controlling Reservoir Fluid Distribution?

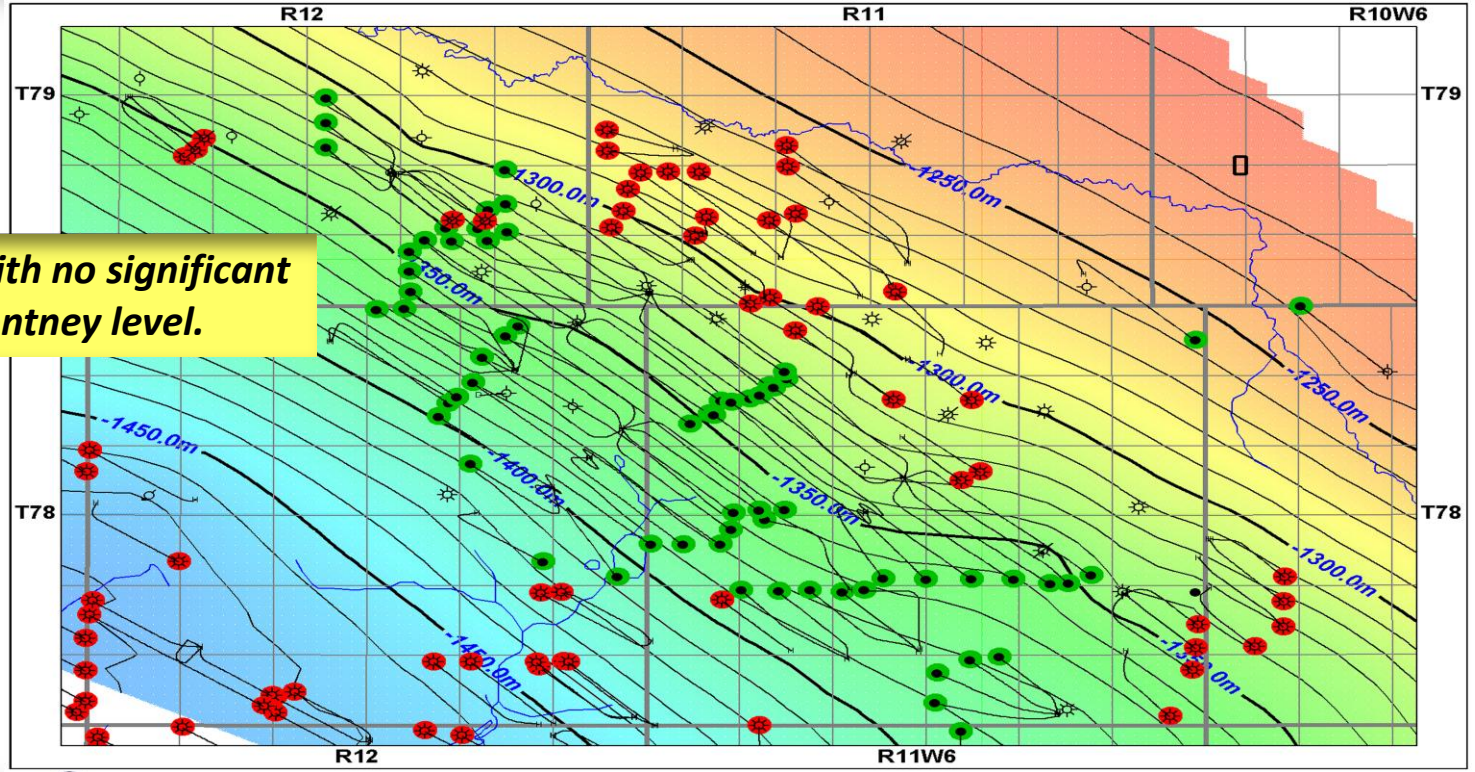


LEUCROTTA EXPLORATION INC.

Gordondale

subsea Top of Lower Montney

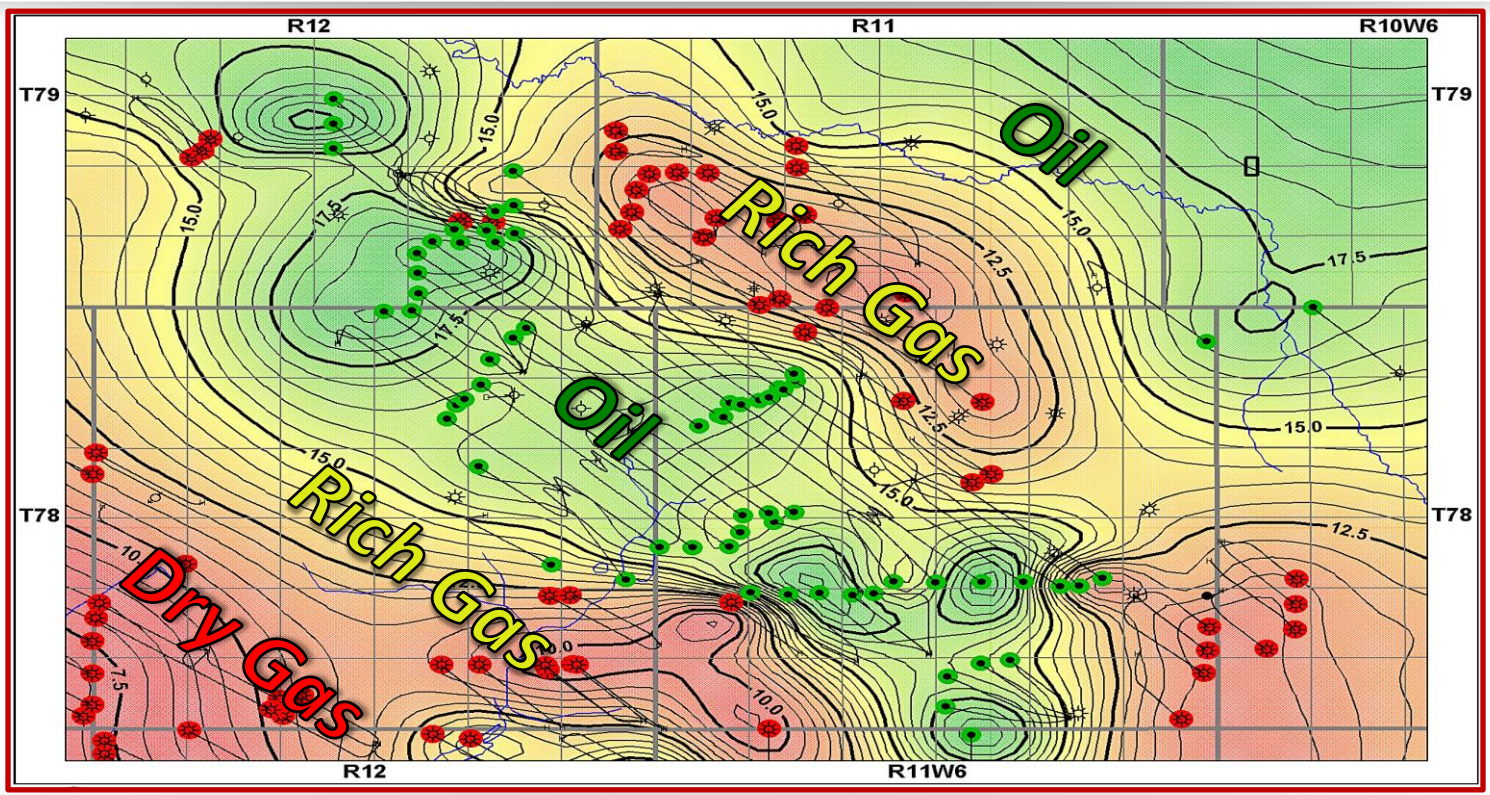
Monocline surface with no significant faulting at Lower Montney level.



LEUCROTTA EXPLORATION INC.

Gordondale

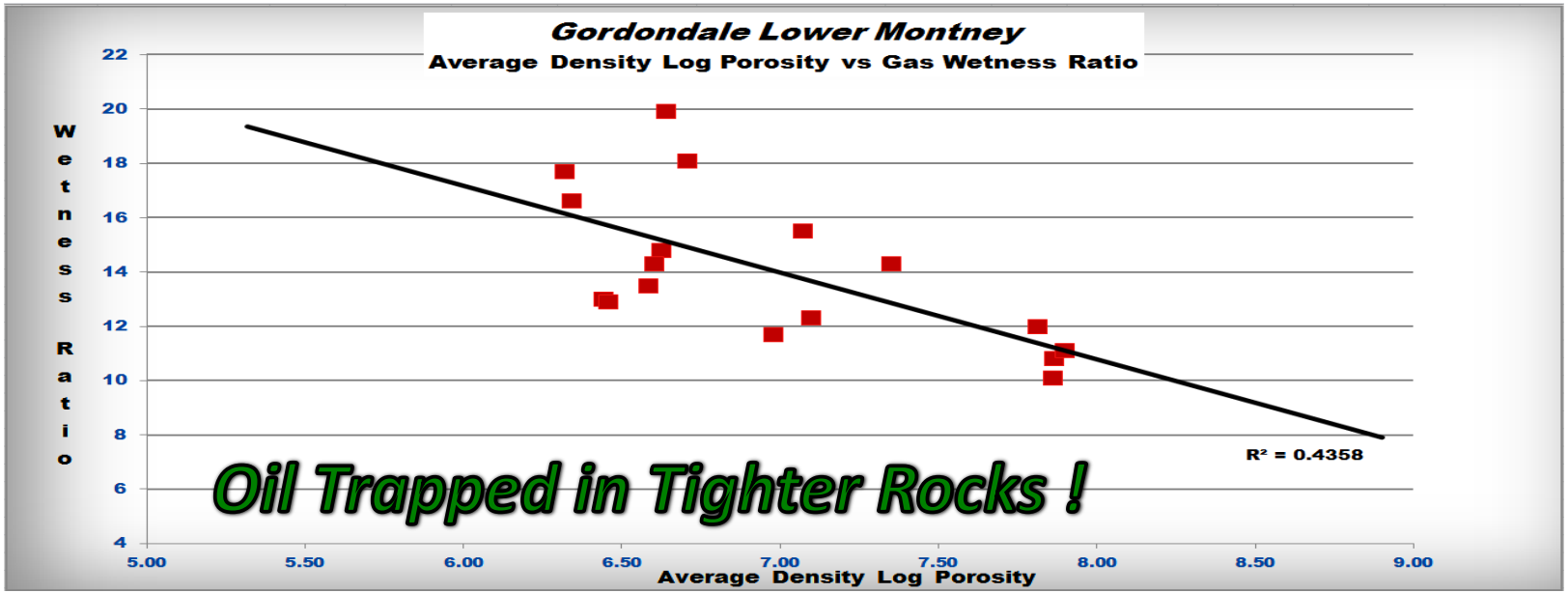
Lower Montney Gas Wetness Ratio



LEUCROTTA EXPLORATION INC.

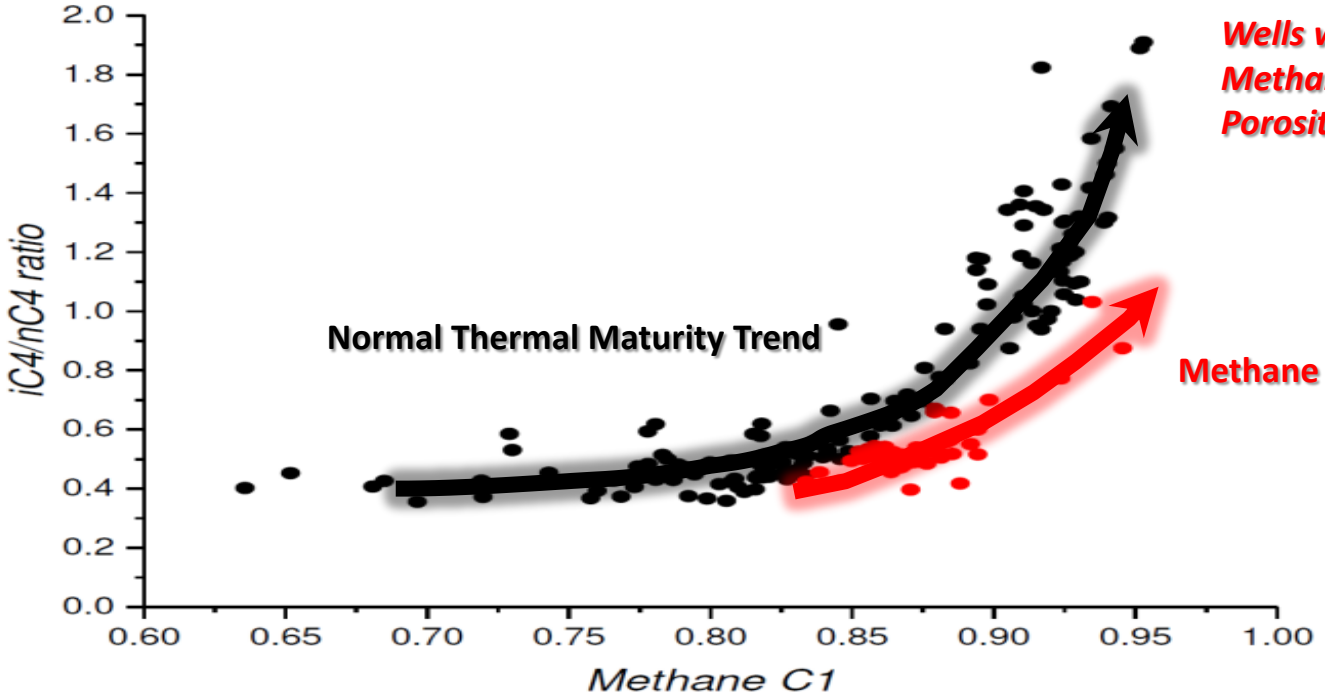
Gordondale

Porosity is Controlling Reservoir Fluid Distribution?



LEUCROTTA EXPLORATION INC.

IC4/NC4 to C1 Ratio Gordondale Area

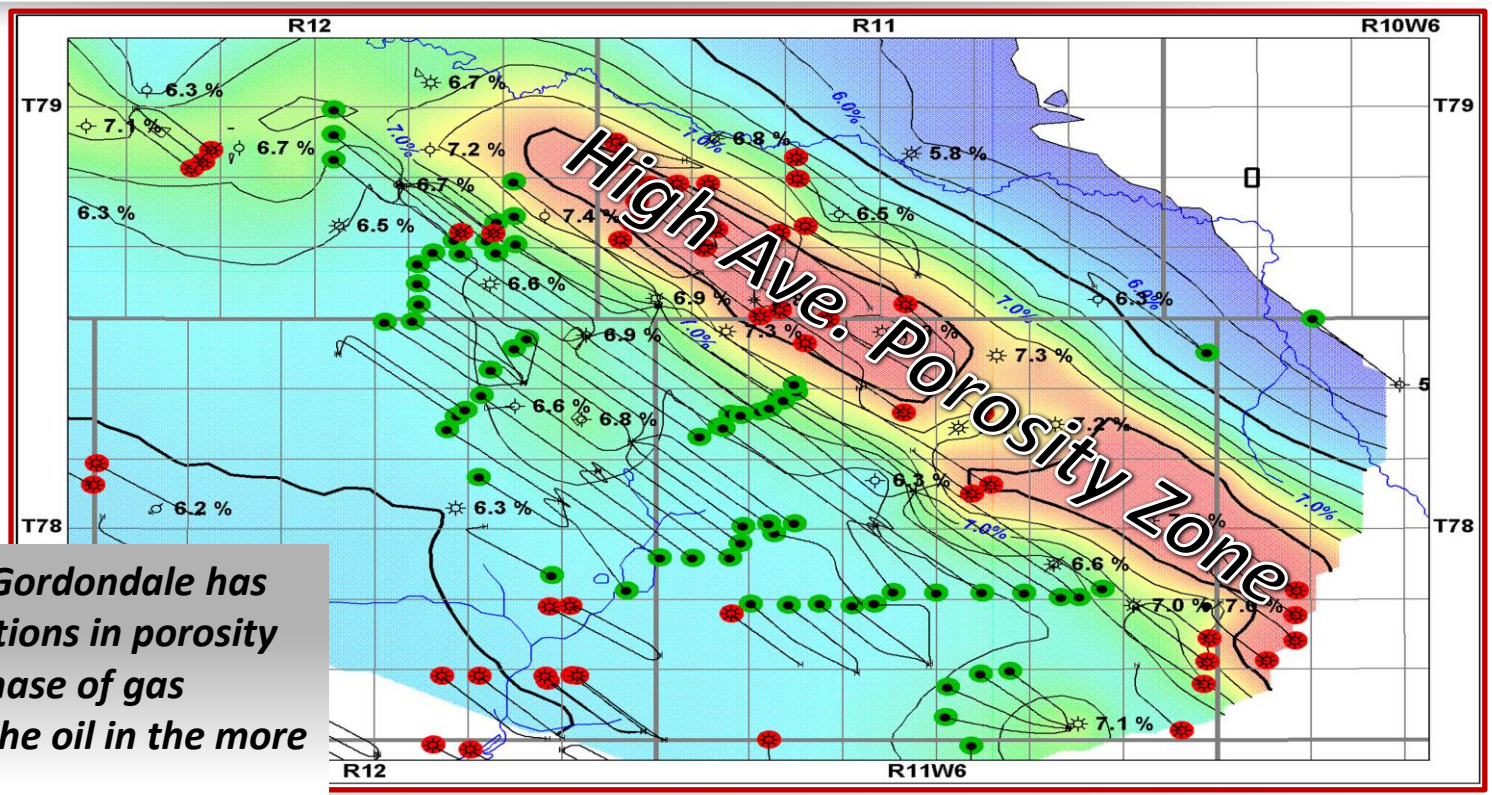


Wells with elevated Methane in the Higher Porosity Region

LEUCROTTA EXPLORATION INC.

Gordondale

Average Porosity Lower Montney

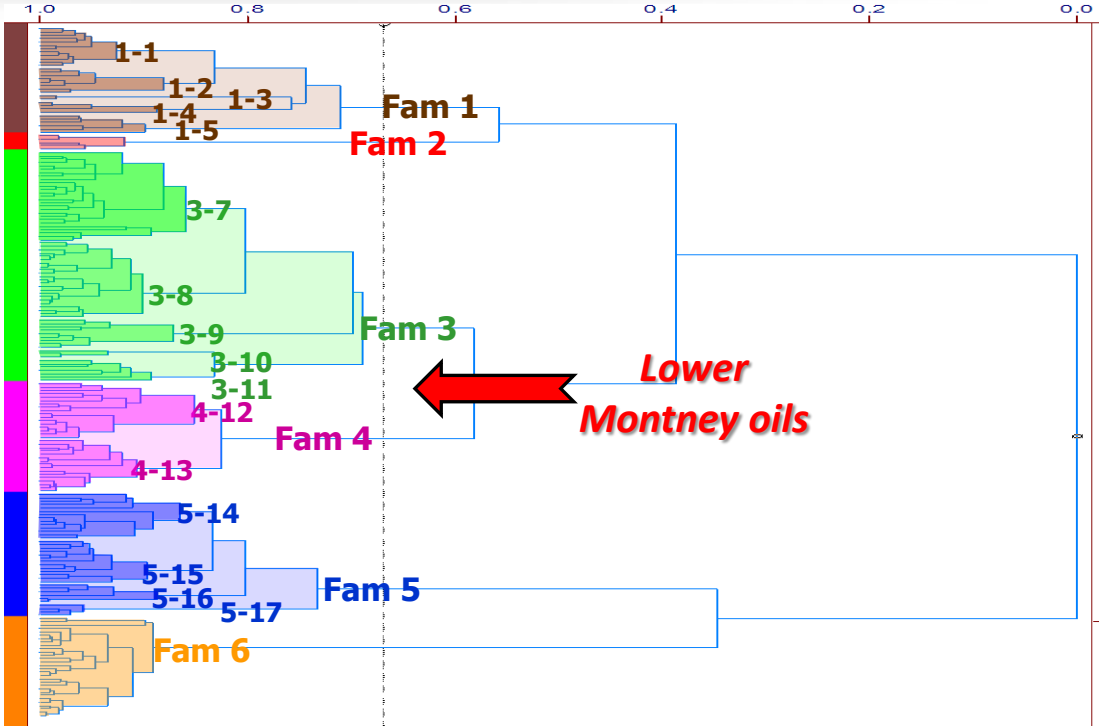


Maturation Profile at Gordondale has been effected by variations in porosity as a result of a later phase of gas migration, displacing the oil in the more porous rock.

Lower Montney

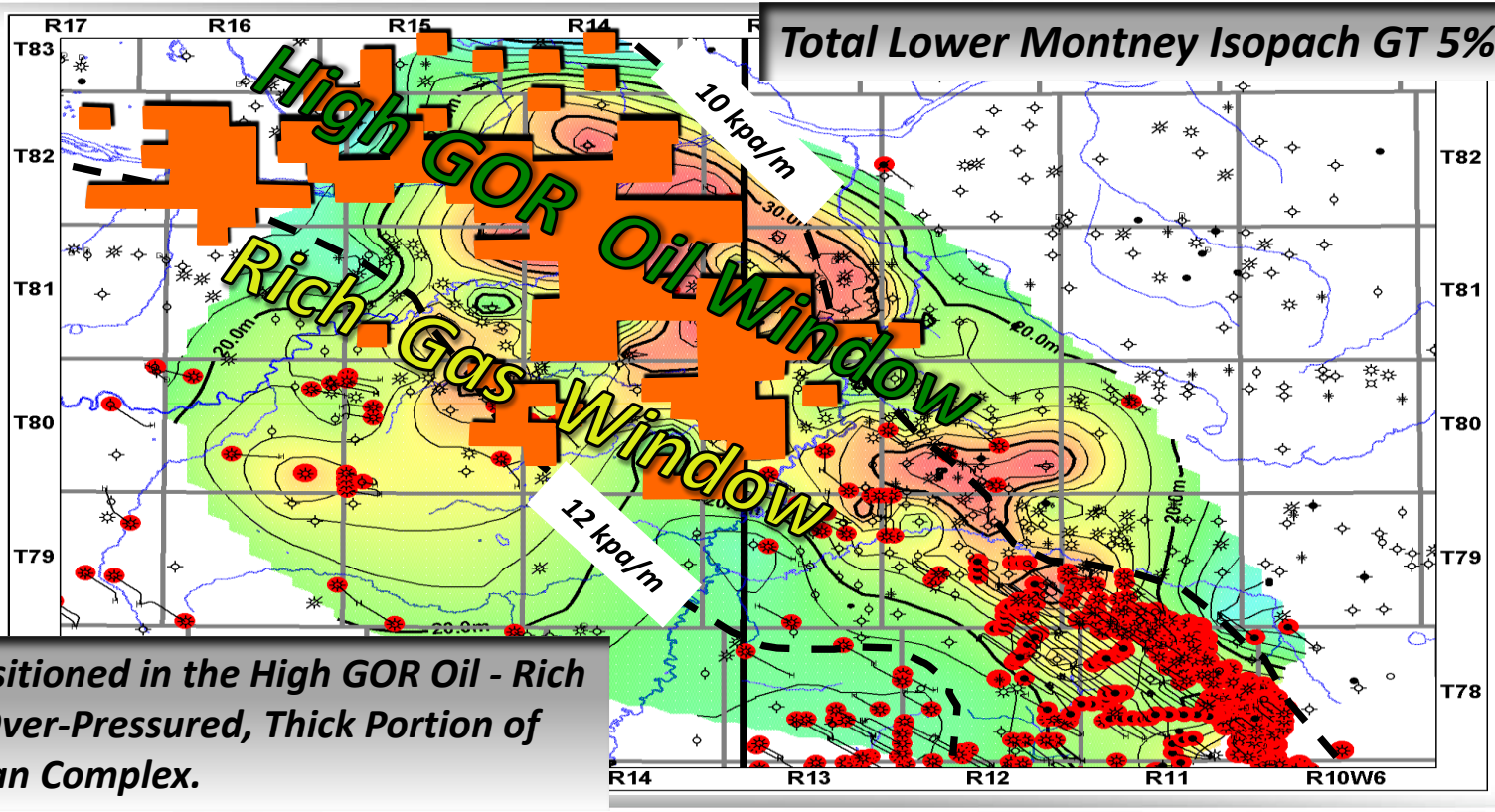
Triassic Marine Type II-III Source Rock

- ***Lower Montney oil with varying API gravities (37 -44^0 API) were generated from a Triassic age source rock (Type II-III) in a distal shale setting characteristic of the Doig Phosphate GeoMark Family 3-11 oils***
- ***More oil-source rock correlations need to be done confirm findings.***



LEUCROTTA
EXPLORATION INC.

Go Forward



Leucrotta is positioned in the High GOR Oil - Rich Gas Window, Over-Pressured, Thick Portion of the Turbidite Fan Complex.

LEUCROTTA EXPLORATION INC.

Summary

- ***The Montney is a world class resource play that competes with all the major resource plays in North America.***

- ***Lower Montney Play has evolved over a 30 year period from a conventional to unconventional play. This evolution is a result of the geology of a submarine fan complex and advancement of technology in the E&P sector.***

LEUCROTTA EXPLORATION INC.

Summary continued

- ***Fan complex deposition is controlled by the Paleozoic fault system of the Ft. St. John Graben Complex.***
- ***Reservoir fluid display a normal maturation hydrocarbon profile with dry gases in the basin center, transitioning to rich gas and light oil on the basin margins.***
- ***The maturation profile can be displaced due to local changes in porosity (permeability?).***
- ***Hydrocarbons were generated from a Type II-III Triassic aged "Doig Like" source rock whose biomarkers correlate to Geomark Family 3-11 oils.***

LEUCROTTA EXPLORATION INC.

Summary continued

"When you change the way you look at things, the things you look at change."
Max Plank, Nobel Laureate and father of Quantum Physics

"We changed the way we looked at this play and the play changed to enable us to find oil & gas in a new place with new idea's!"