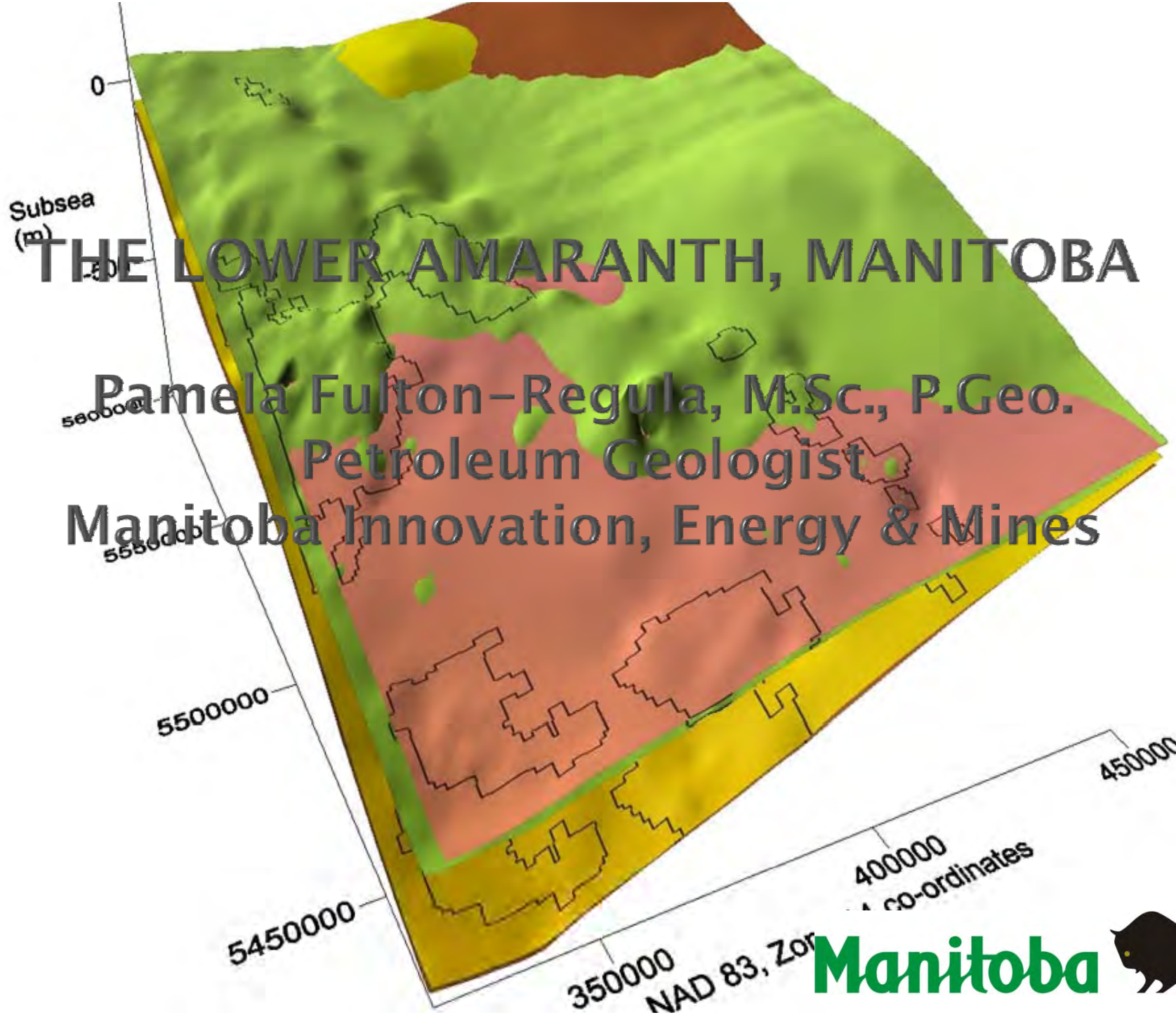


THE LOWER AMARANTH, MANITOBA

Pamela Fulton-Regula, M.Sc., P.Geo.
Petroleum Geologist
Manitoba Innovation, Energy & Mines

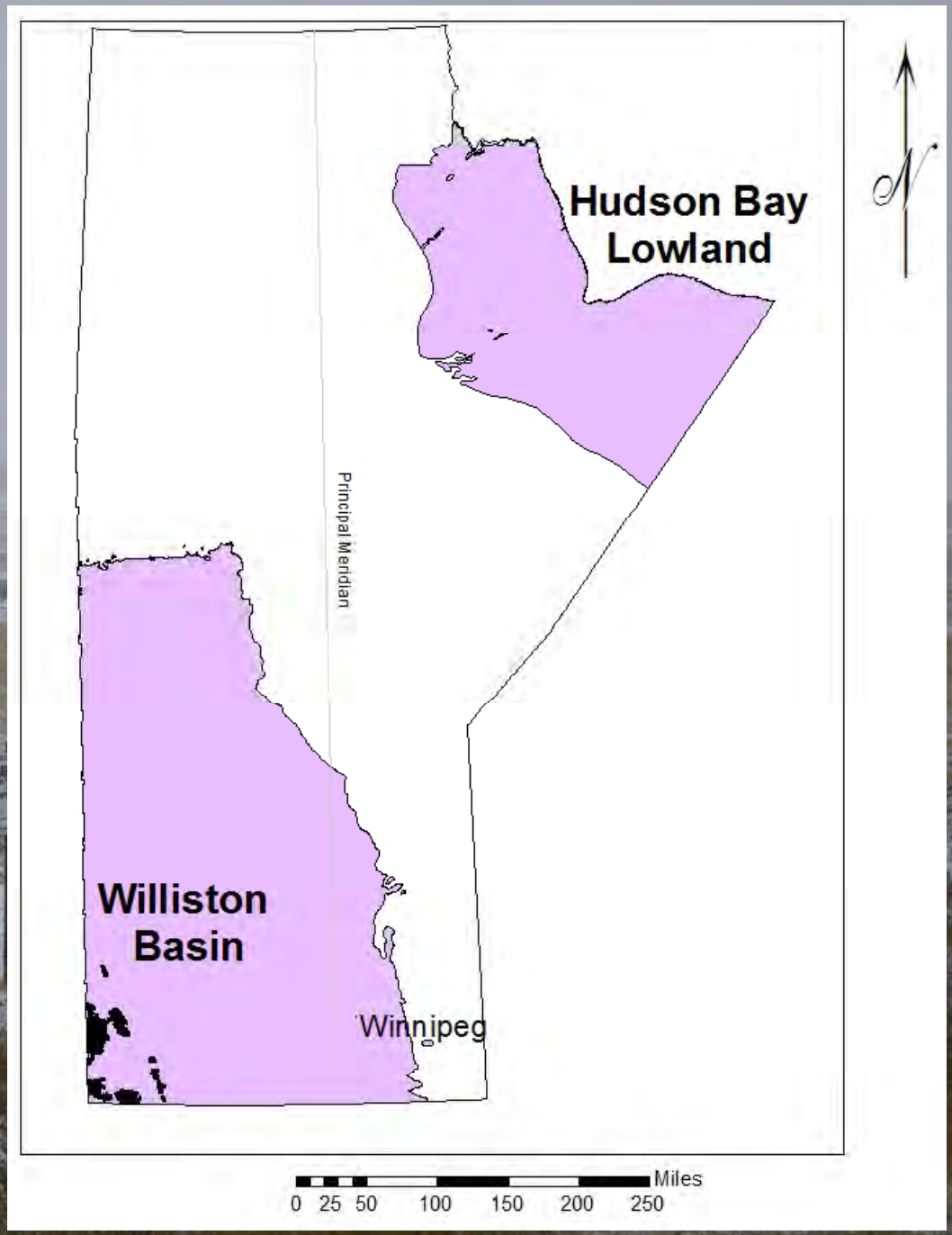
Manitoba


Manitoba
Lower Amaranth
=
Saskatchewan
Lower Watrous
=
North Dakota
Spearfish
Manitoba

MANITOBA OVERVIEW MAP

There are two major sedimentary basins in Manitoba, Hudson Bay and the Williston Basin.

All oil production in Manitoba is presently in the Williston Basin located in south western Manitoba.



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The Williston Basin in Manitoba

Period	Formation
Quaternary	Glacial Drift
Tertiary	Turtle Mountain
Cretaceous	Boissevain
	Pierre Shale*
	Carlile*
	Favel*
	Ashville*
	Swan River*
Jurassic	Sucess
	Waskada
	Melita●
	Reston
	Upper Amaranth
Triassic	Lower Amaranth●
Permian	St. Martin Complex
Pennsylvanian	
Mississippian	Charles
	Mission Canyon●
	Lodgepole●
	Bakken●
Devonian	Three Forks●
	Birdbear*
	Duperow*
	Souris River*
	Dawson Bay*
	Prairie Evaporite*
	Winnipegosis*
	Elm point
	Ashern
Silurian	Interlake Group*
Ordovician	Stonewall
	Stony Mountain*
	Red River*
	Winnipeg*
Cambrian	Deadwood
Precambrian	

● Producing Oil

* Oil Shows

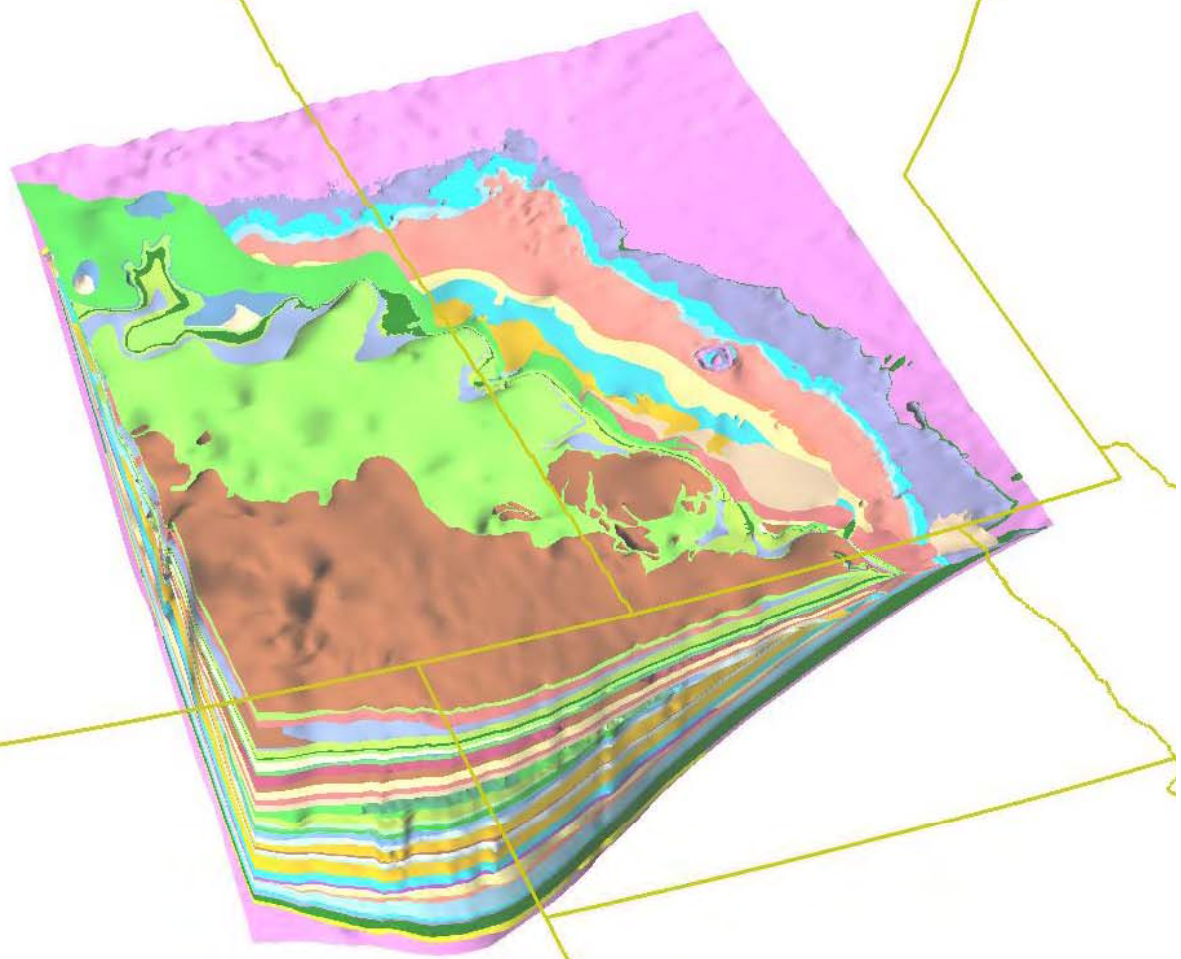

Image created by G. Keller of Innovation Energy & Mines for the TGI Project.

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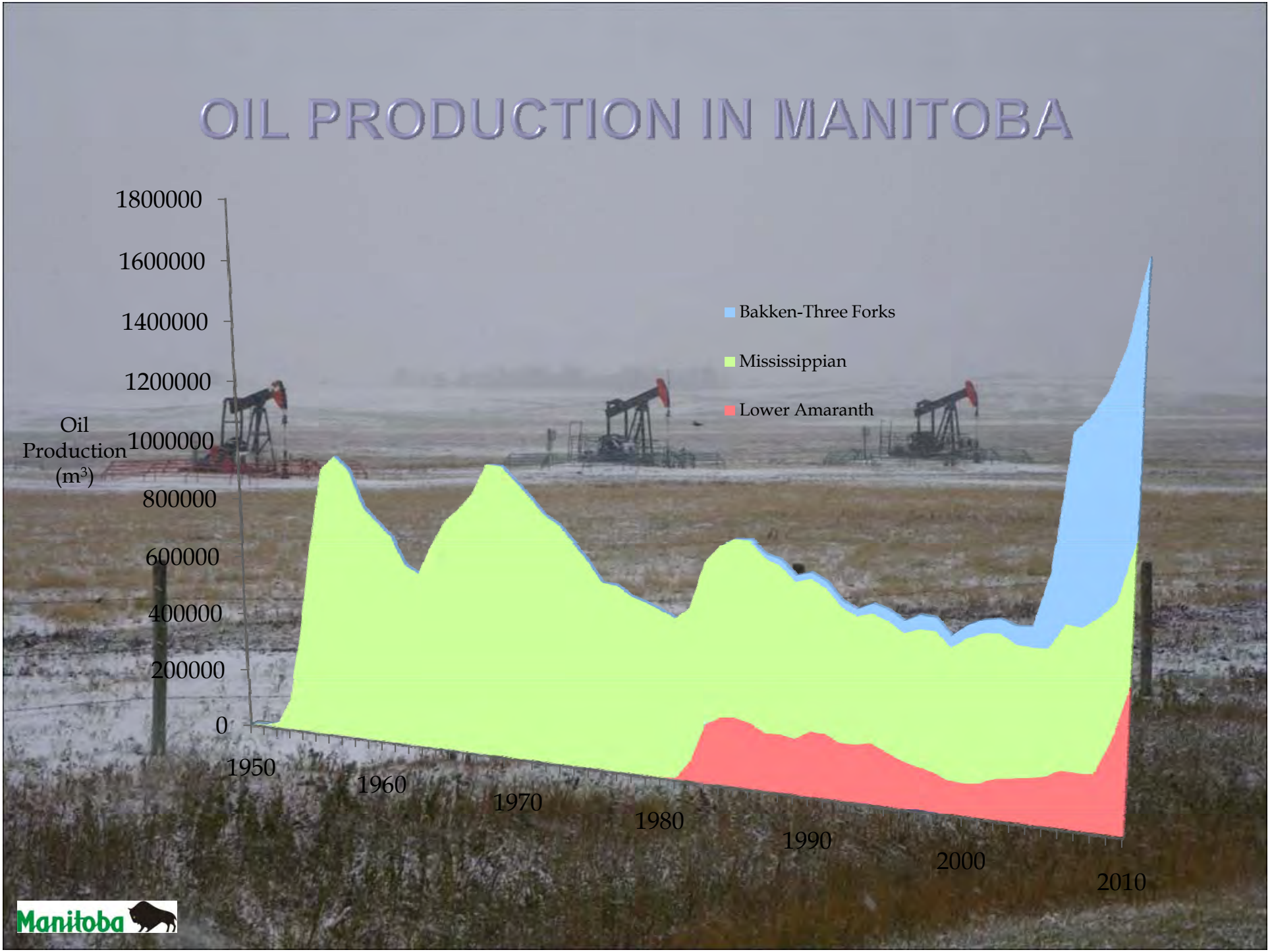
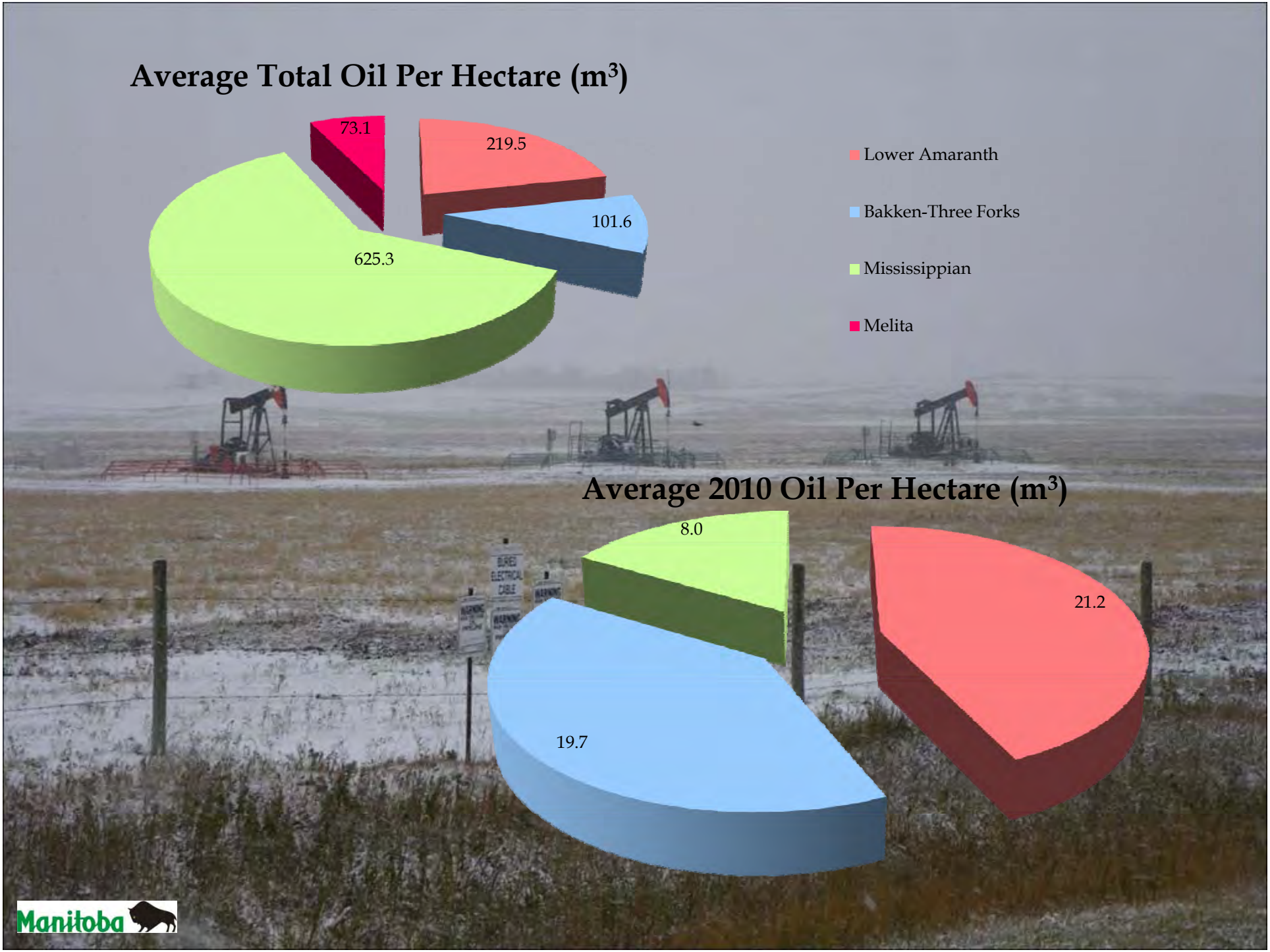
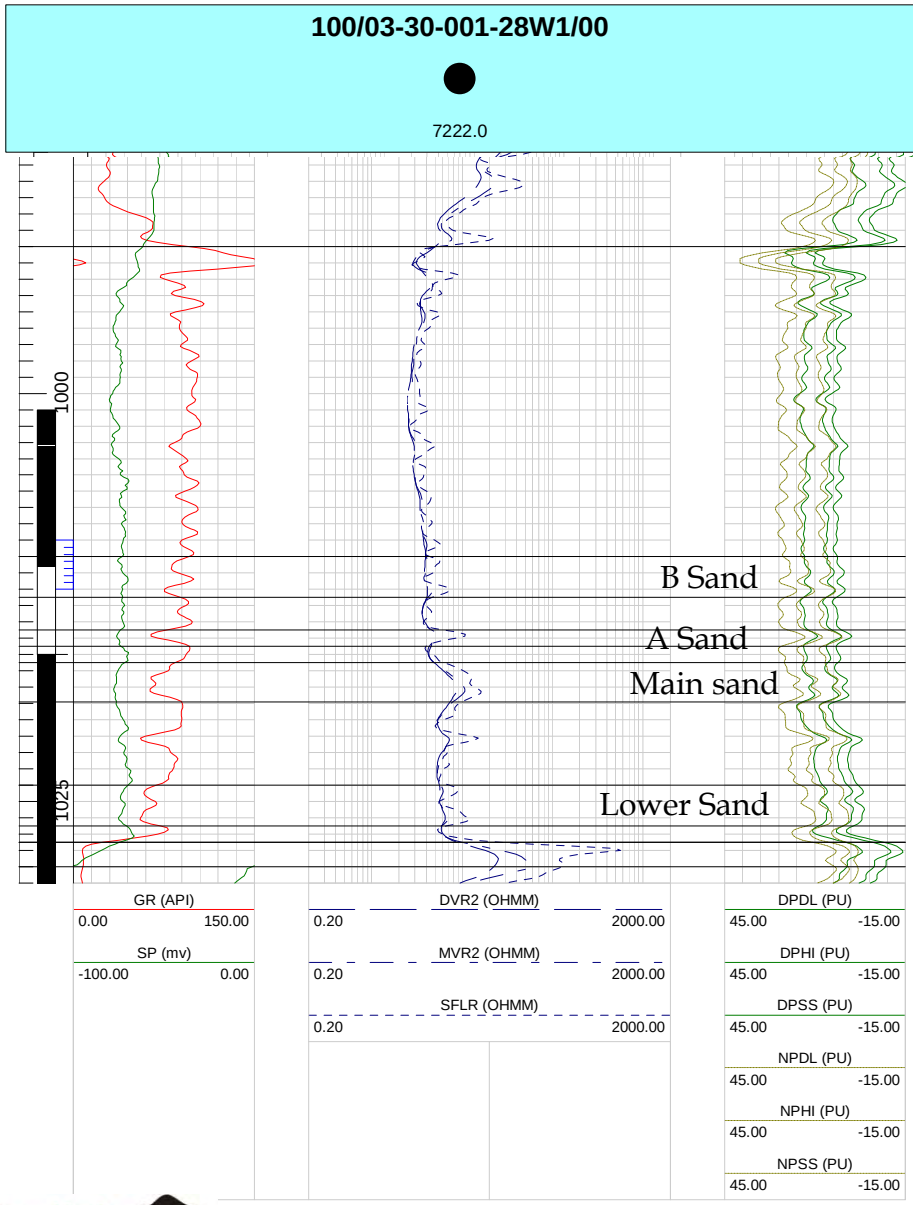
OIL PRODUCTION IN MANITOBA



Manitoba

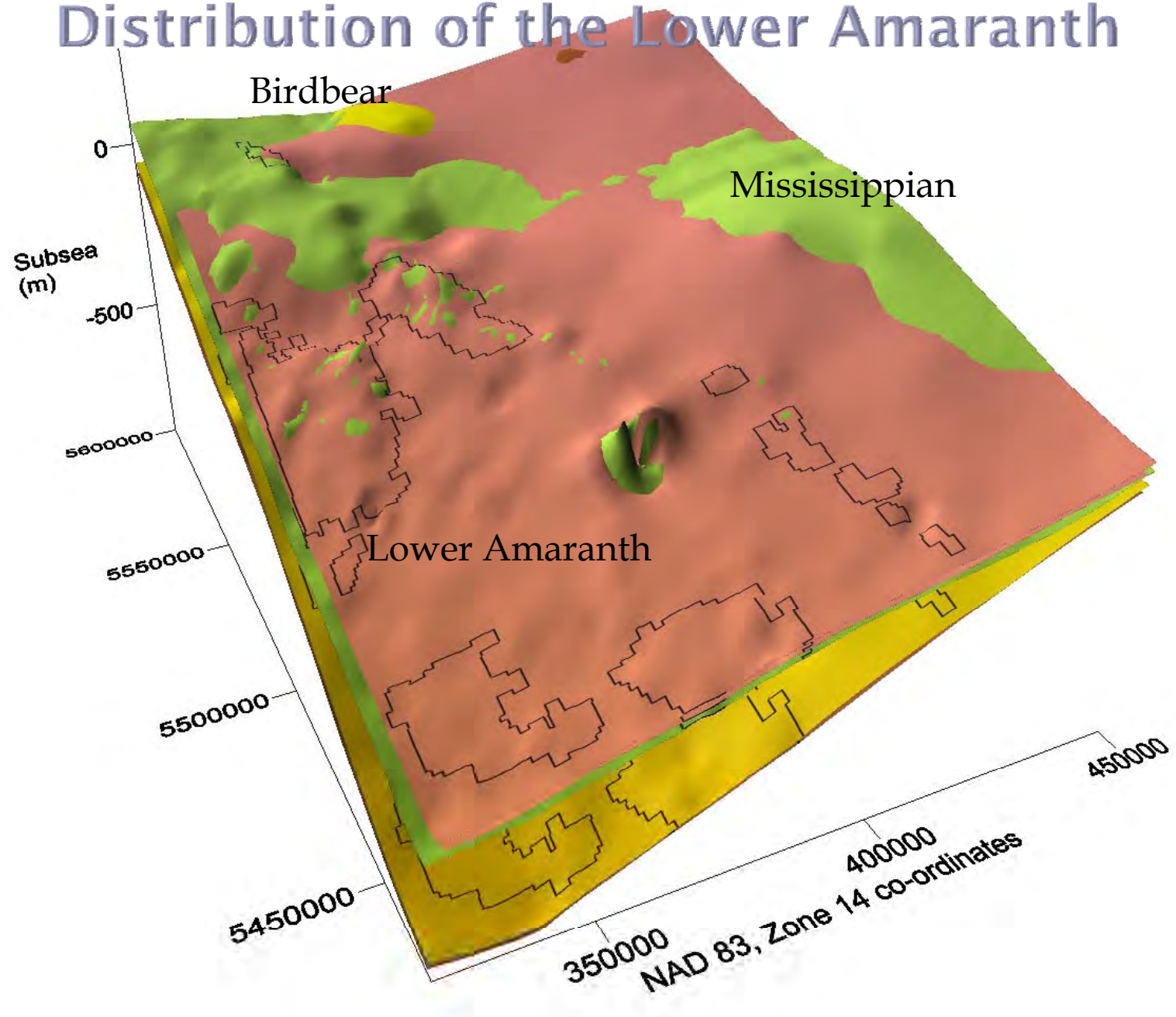

Average Total Oil Per Hectare (m³)
73.1
219.5
101.6
625.3
Lower Amaranth
Bakken-Three Forks
Mississippian
Melita
Average 2010 Oil Per Hectare (m³)
8.0
21.2
19.7
Manitoba

Lower Amaranth



This vertical well produced 9m^3 of oil during the first 105 hours of production.

Distribution of the Lower Amaranth



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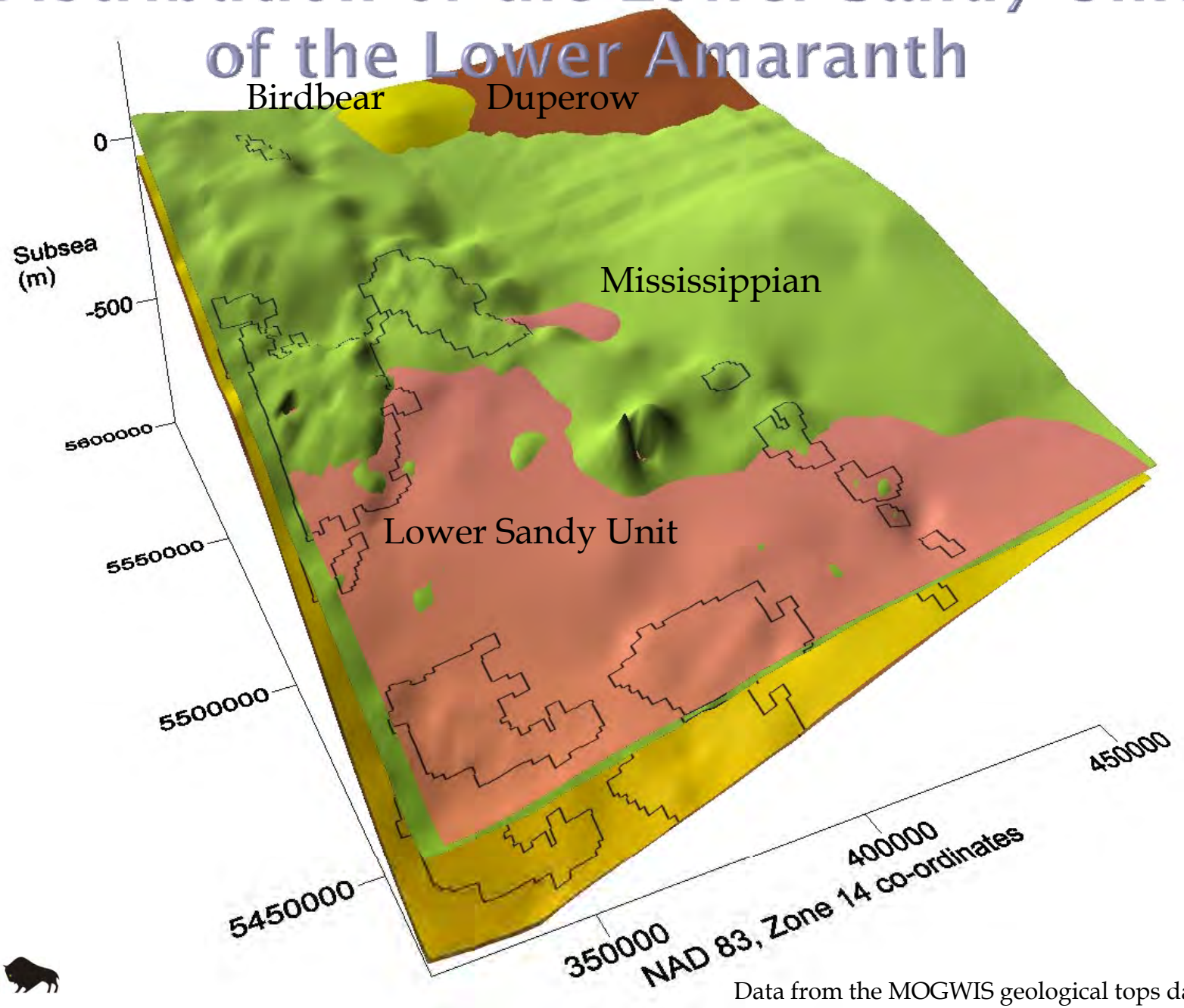
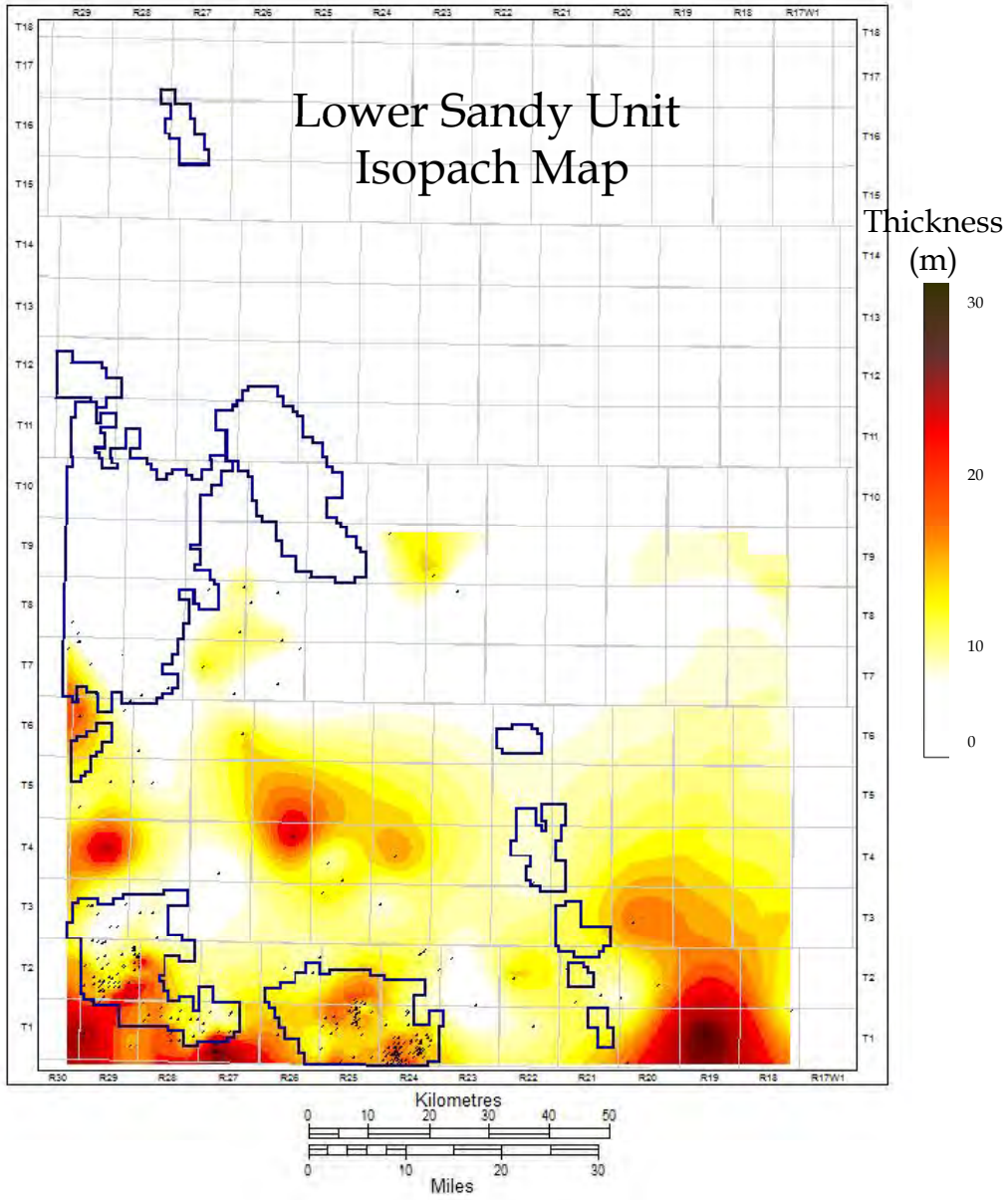
Data from the MOGWIS geological tops database.

Distribution of the Lower Sandy Unit of the Lower Amaranth



Manitoba

Data from the MOGWIS geological tops database.



Data from the MOGWIS geological tops database, contour method = kriging.

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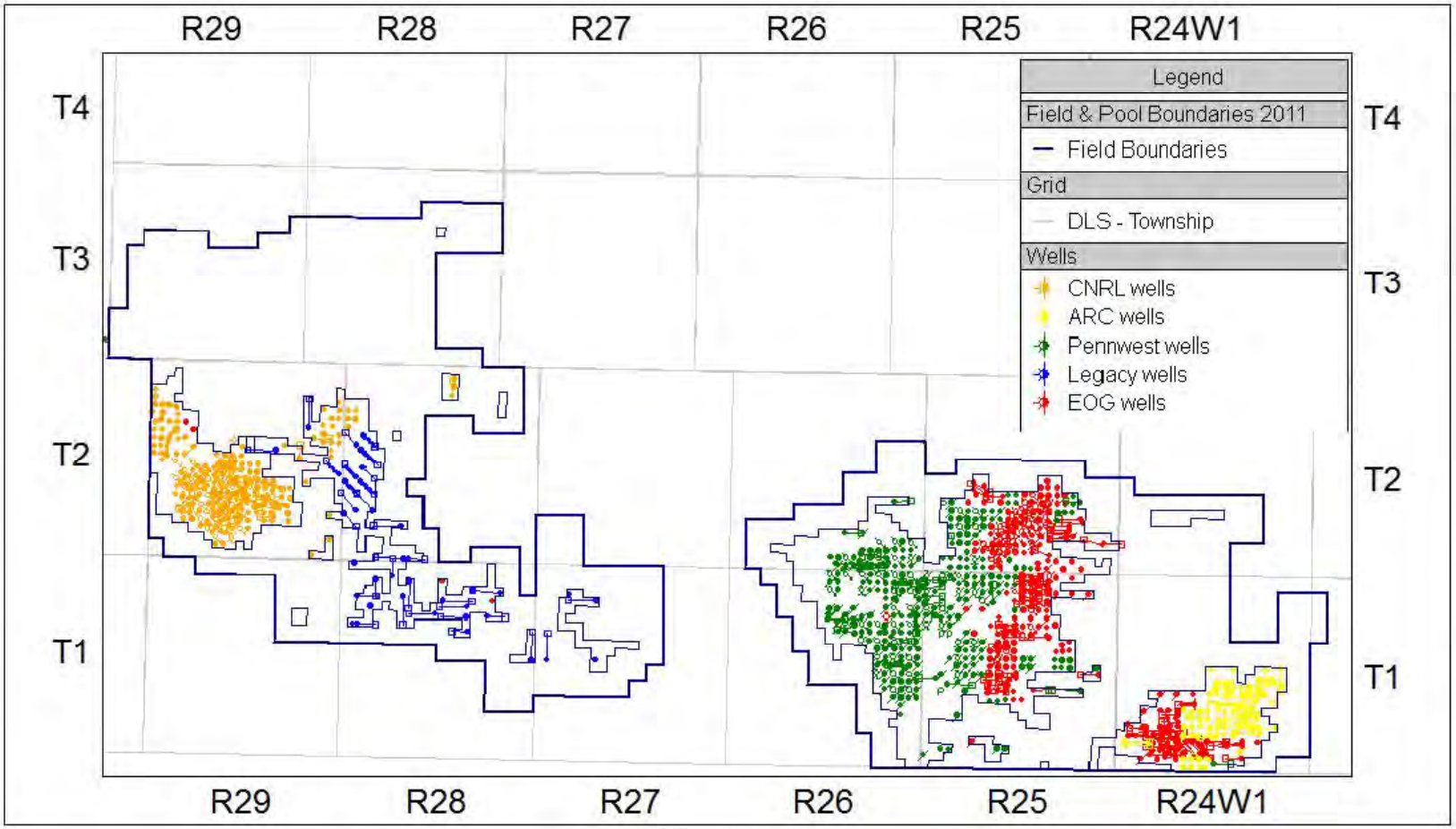
Lower Amaranth Producers



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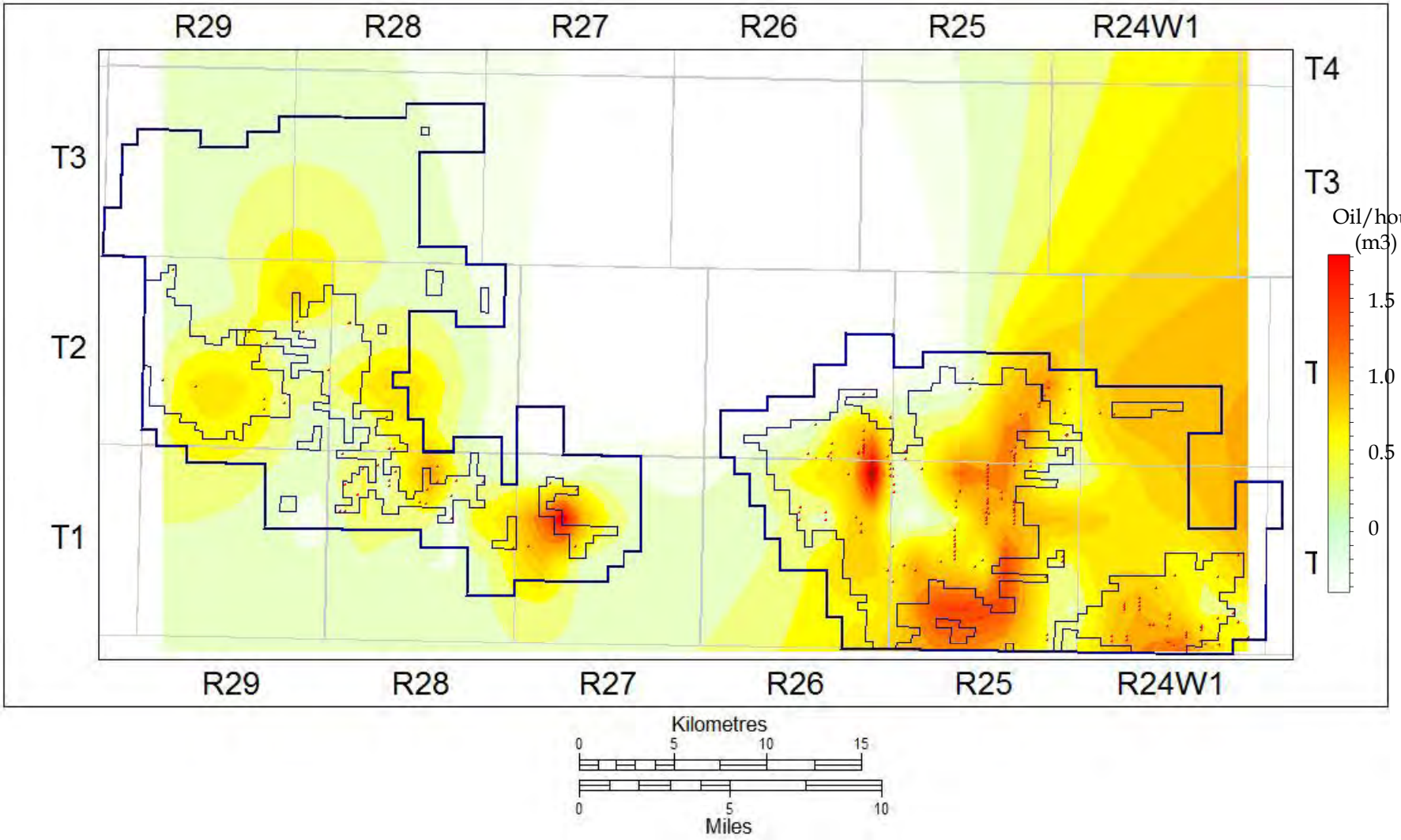
Initial Oil Production



This data was taken from non-confidential Initial Production Reports submitted from January 1st 2010 to March 31st 2011.
Data presented in Dominion Land Survey System grid, contour method = Kriging.

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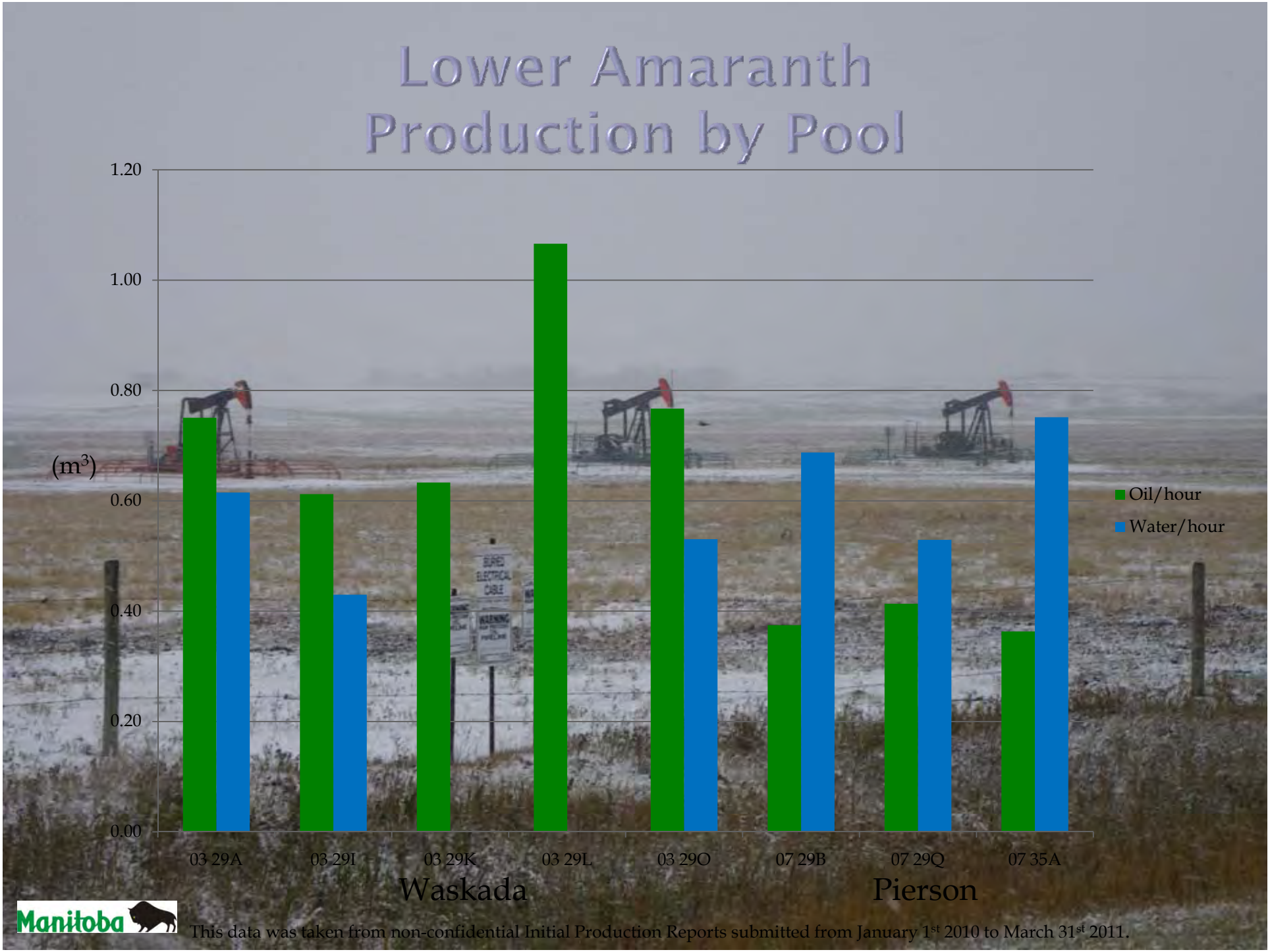
Lower Amaranth Production by Pool



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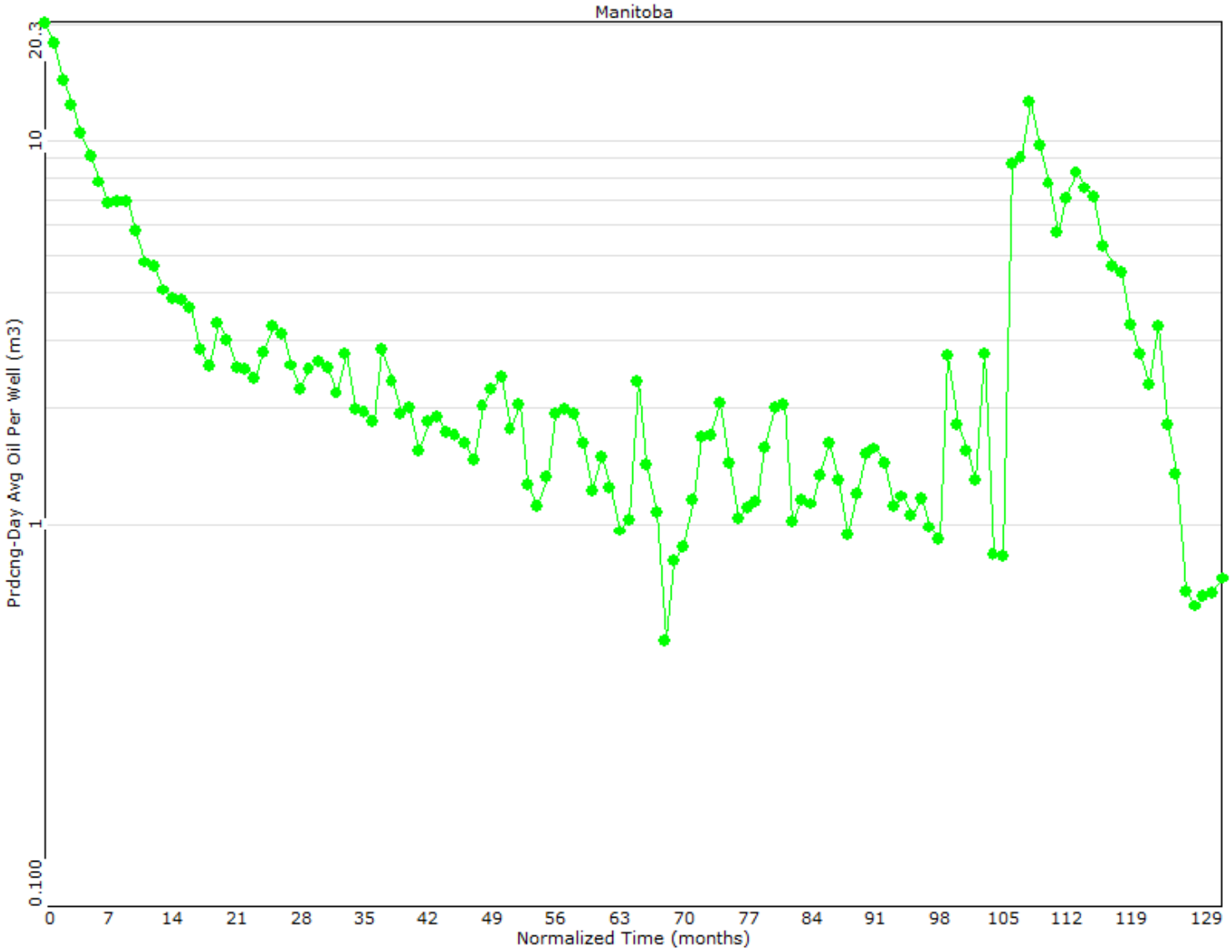
This data was taken from non-confidential Initial Production Reports submitted from January 1st 2010 to March 31st 2011.

Waskada 03 29A Pool



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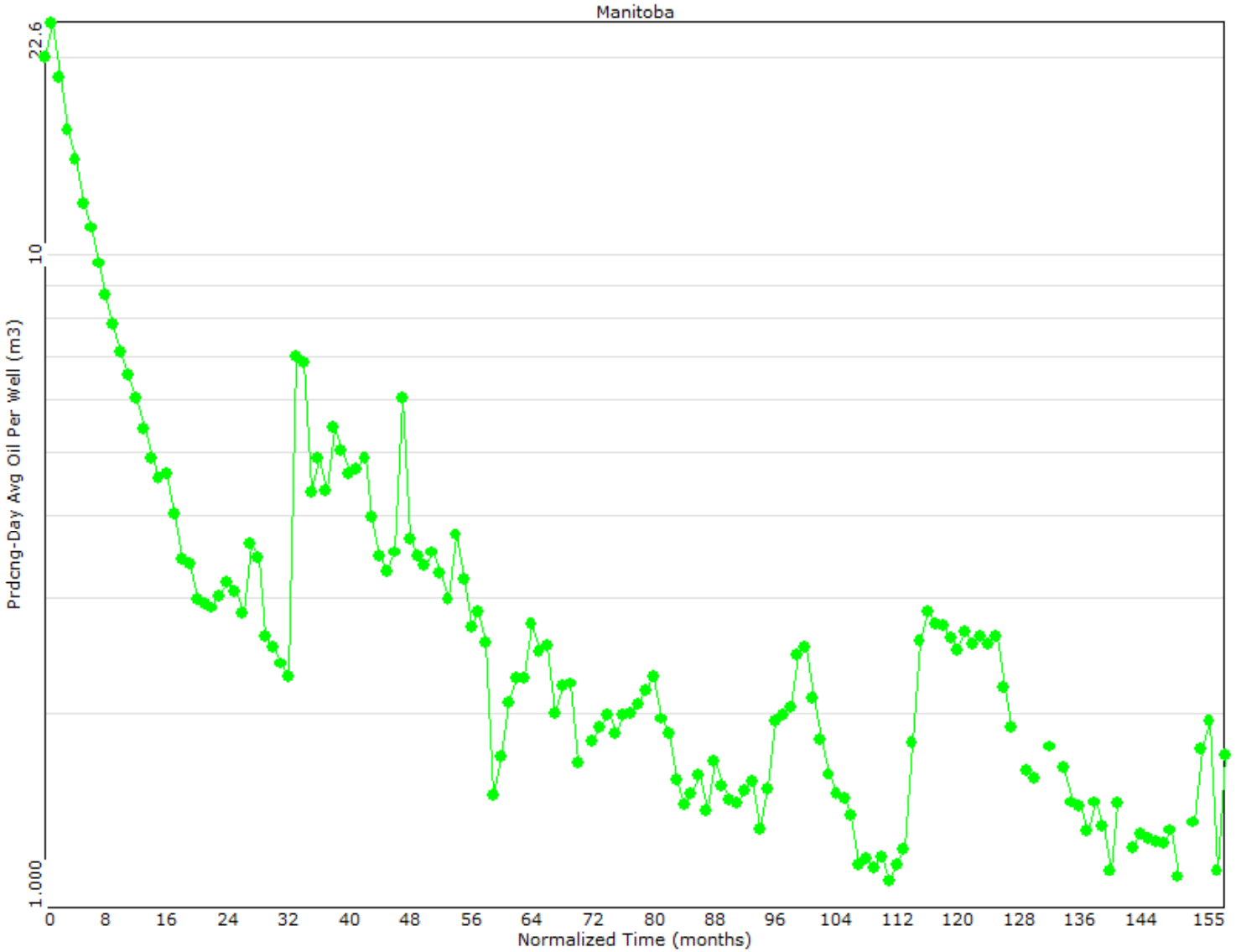
Data taken from geoSCOUT Decline Pro, current to March 30th 2011.

Waskada 03 29I Pool



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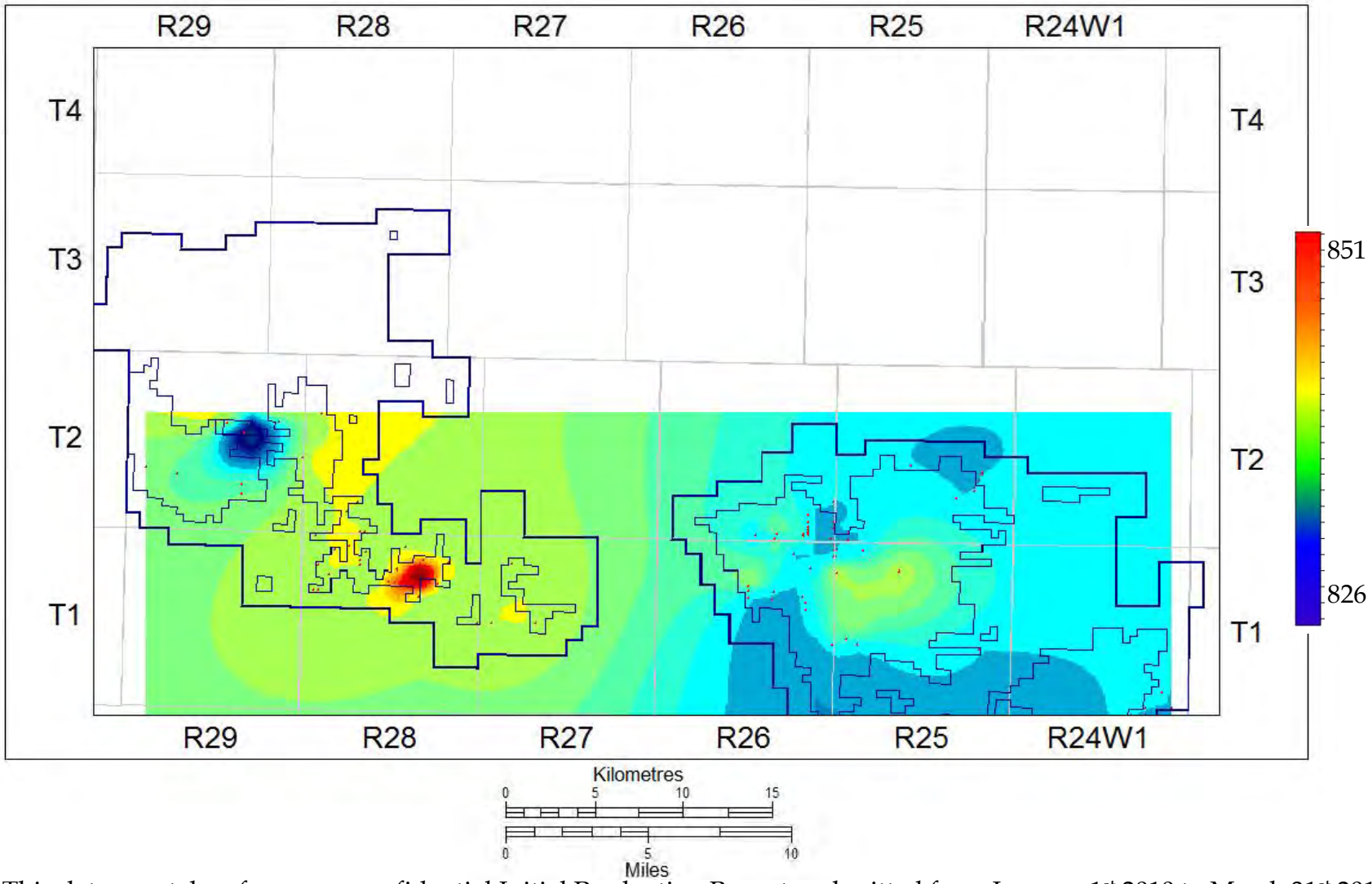
Data taken from geoSCOUT Decline Pro, current to March 30th 2011.

Oil Quality

Typical absolute oil densities are between 826 to 853 kg/m3 for the Lower Amaranth.



This data was taken from non-confidential Initial Production Reports submitted from January 1st 2010 to March 31st 2011.
Data presented in Dominion Land Survey System grid, contour method = Kriging.

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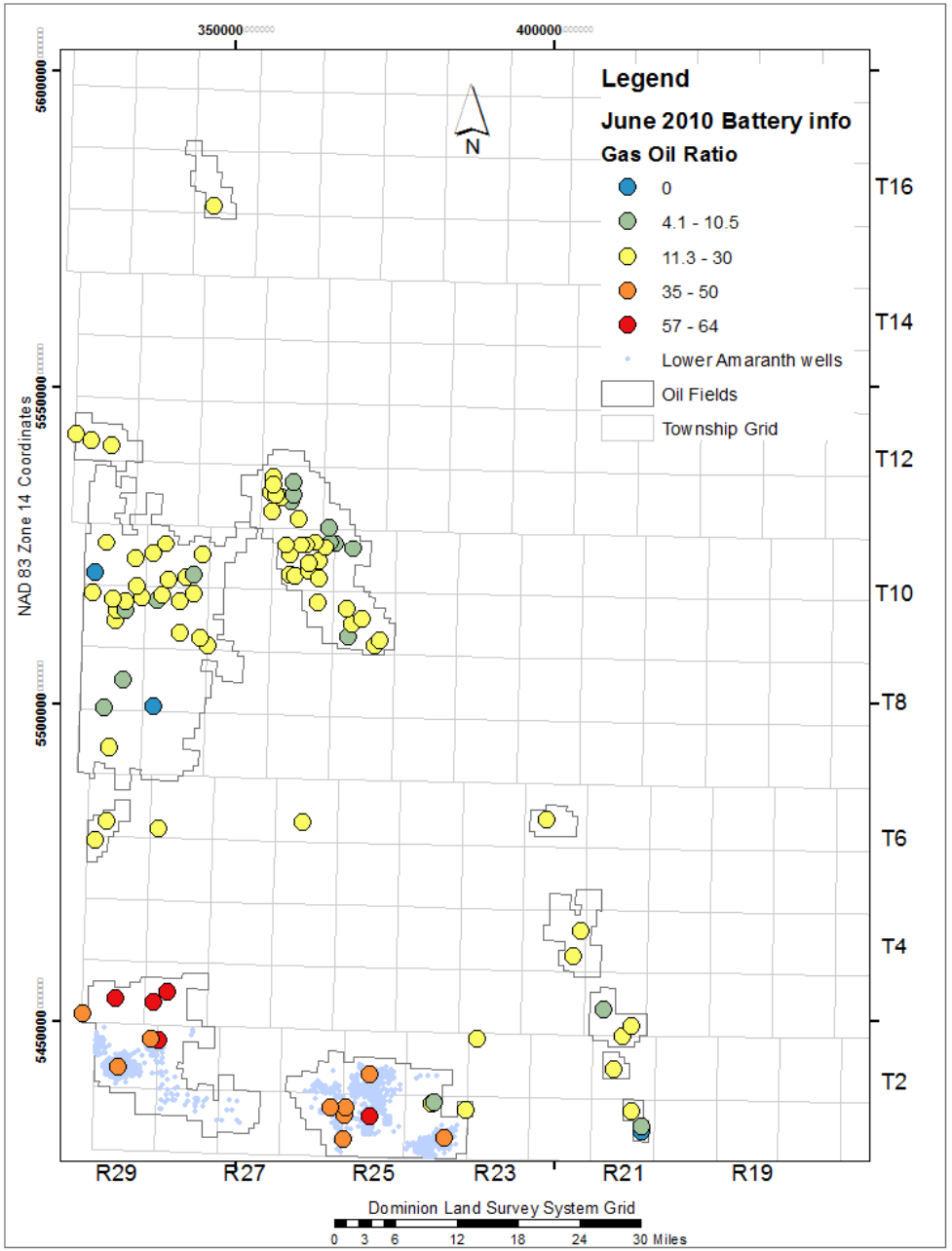
Gas Oil Ratio

In Manitoba, the highest Gas Oil Ratio's can be found in the Pierson and Waskada Oil Fields.

Recorded Gross heating values for this gas range from 33 to 64 MJ/m3 in Pierson and 15 to 70 MJ/m3 in the Waskada Oil Field.



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HORIZONTAL DRILLING IN MANITOBA

Drilling:

- Single leg monobore to toe, using mud motors, typically 500 to 750m in length;
- Multiple parallel well bores.

Completion method 1:

- Production casing is run to TD and cemented to surface.
- Tubing conveyed perforating guns, with 15-23, 1m, 0° phase guns, shooting straight up (9 shots/meter);
- Coiled tubing conveyed frac assembly with packers at 5m intervals. 250L of acid pumped followed by 5 tonne sand frac.

Completion method 2:

- Production casing is run to TD and cemented to surface.
- Coiled tubing conveyed brazer jet and packer "Mongoose Tool" perforates and fracs in the same run (4 jets at 0.3m intervals and 60° phasing);

Completion method 3:

- Downhole frac ports are installed in production casing string at 20-50m intervals
- Frac ports are isolated and the frac proceeds as normal (4 ports per collar @ 90°).

Best Initial production reports from the Lower Amaranth in Waskada with production rates up to 93m³/day.

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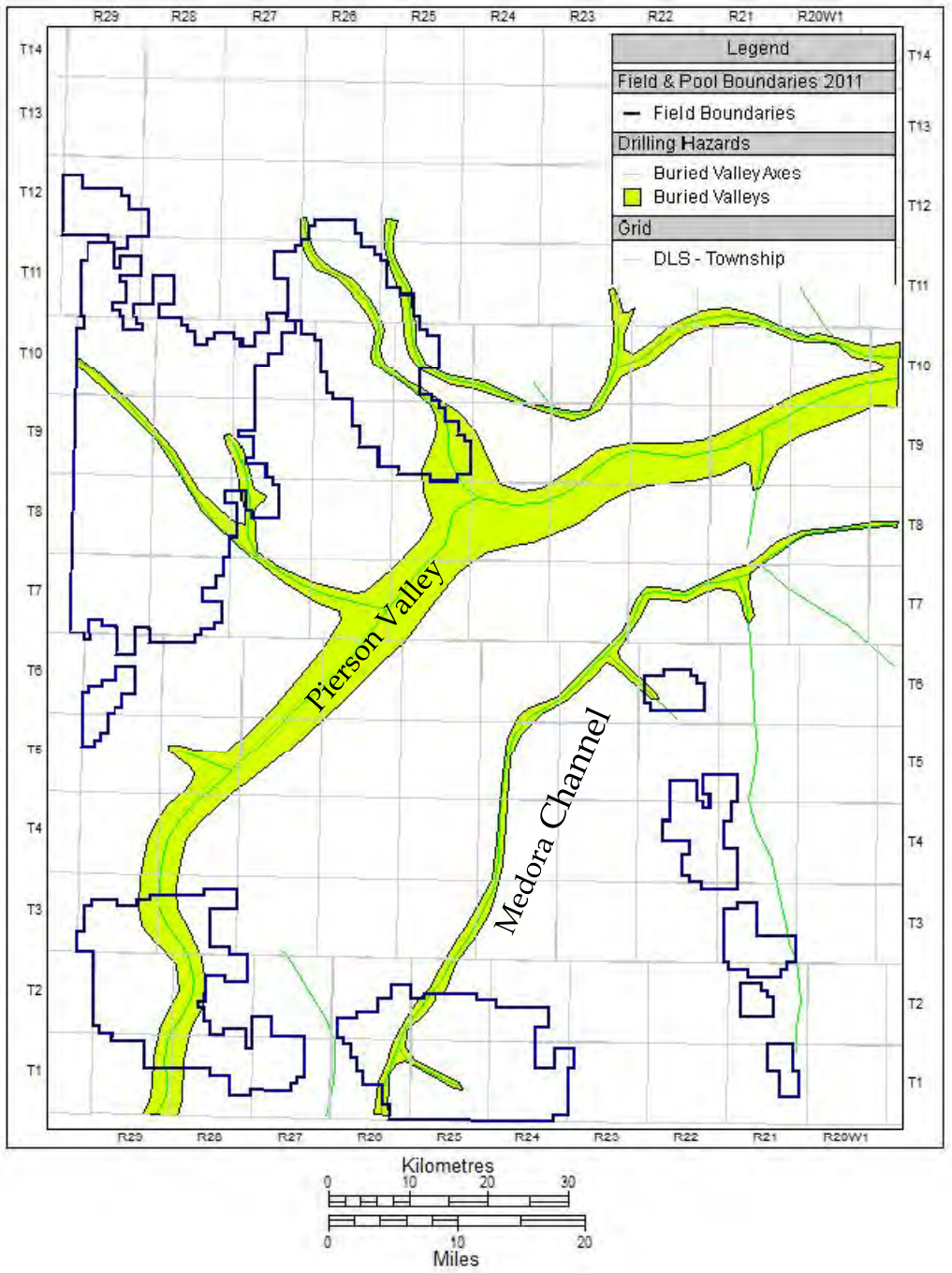
Lower Amaranth Drilling Issues

Buried valleys

The Swan River formation

Well bore collisions



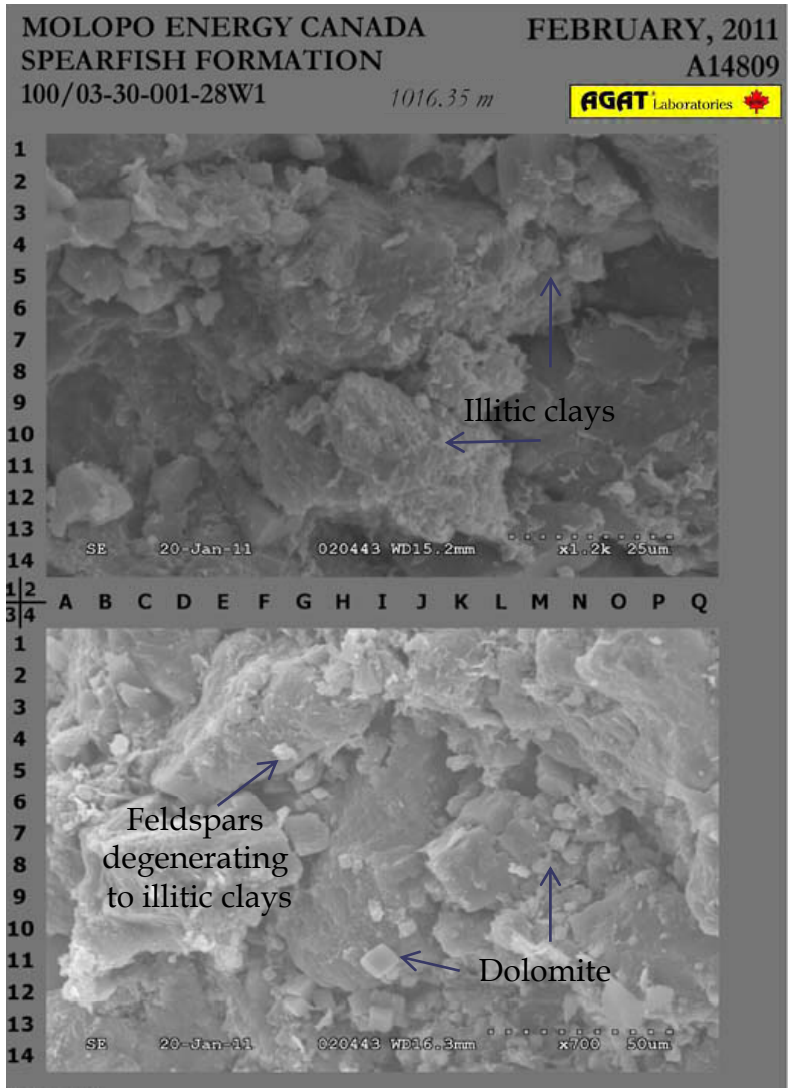
Map adapted from Klassen & Wyder, 1970.

Manitoba

Known Reservoir Issues

Reservoir problems for the Lower Amaranth may include the following:

- A heterogeneous pore system and abundant ineffective porosity within the matrix material;
- Fines, such as illitic clays and authigenic kaolinite, may migrate to pore blocking positions;
- The presence of swelling smectite clays;
- Pyrite which may convert to iron hydroxide gels in the presence of Hydrochloric acid;
- Dolomite which may form calcium fluoride precipitates in the presence of hydrofluoric acid; and,
- Anhydrite cement which may form calcium sulphate scales if formation water and hydrocarbons are produced together from this reservoir.



(Molopo Energy Canada Petrographic Study on 100/08-25-001-28W1 and 100/03-30-001-28W1, 2011.)

Best Completion & Production Practices

Fracture stimulation to create a more homogeneous production environment, improve interconnection of isolated pores and increase flow rates.

Holding production rates under a critical velocity flow rate may avoid migration of the formation fines created by the fracturing process and illitic clays.

Avoiding production of formation water with oil to prevent the precipitation of calcium sulphate scales.

Avoiding hydrochloric and hydrofluoric acids to prevent precipitation of iron hydroxide gels and calcium fluoride precipitates.

Avoiding fresh water based drilling muds in areas with smectite clays. Instead potassium chloride or invert oil based drilling muds should be used.

Manitoba

Thank you!

I would like to thank the staff at the Manitoba Petroleum Branch and
the companies active in Manitoba for collecting, submitting and organizing
the data that has made this presentation possible.

For further information on Manitoba please come see Michelle Nicolas' presentation tomorrow at 8:30 or refer to our website at
www.manitoba.ca/Petroleum

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