

# **Shale gas to Three Forks: Manitoba Geological Survey's petroleum and stratigraphic investigations**

***Michelle Nicolas, P. Geo.***

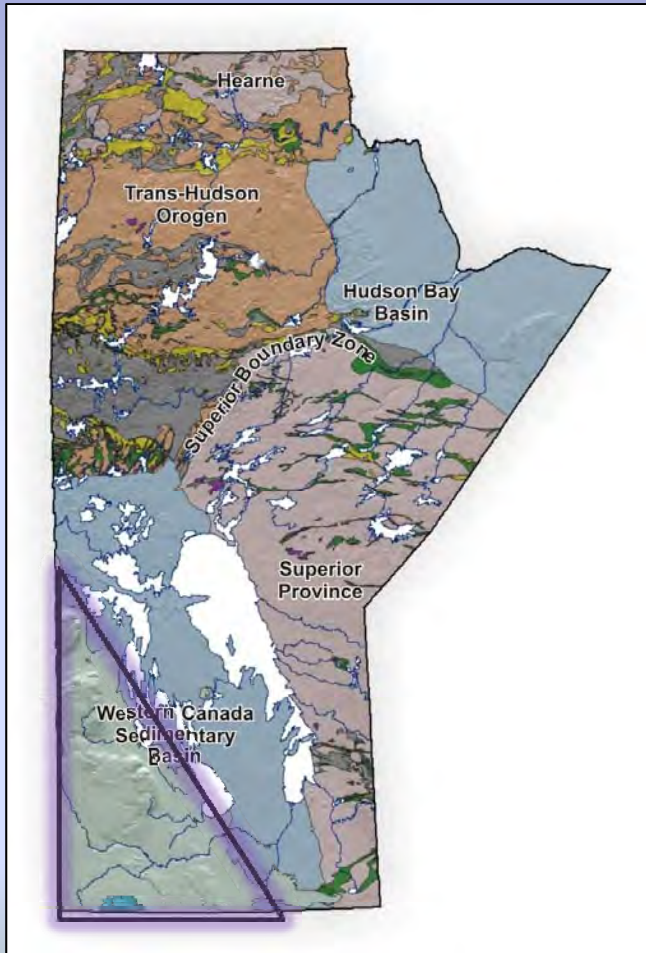
19<sup>th</sup> Williston Basin Petroleum Conference  
Regina, SK  
May 3, 2011



# Current Projects

- **Shallow Unconventional Shale Gas Project**
- **Bakken-Three Forks Project**
- **GEM Energy: Hudson Bay and Foxe Basins Project**
- 3-D Model of Southern Manitoba
- TGI 2: Williston Basin
- CO<sub>2</sub> Storage in the Basal Aquifer
- Cretaceous Gammon Ferruginous Chemostratigraphic Investigations

# Shallow Unconventional Shale Gas Project



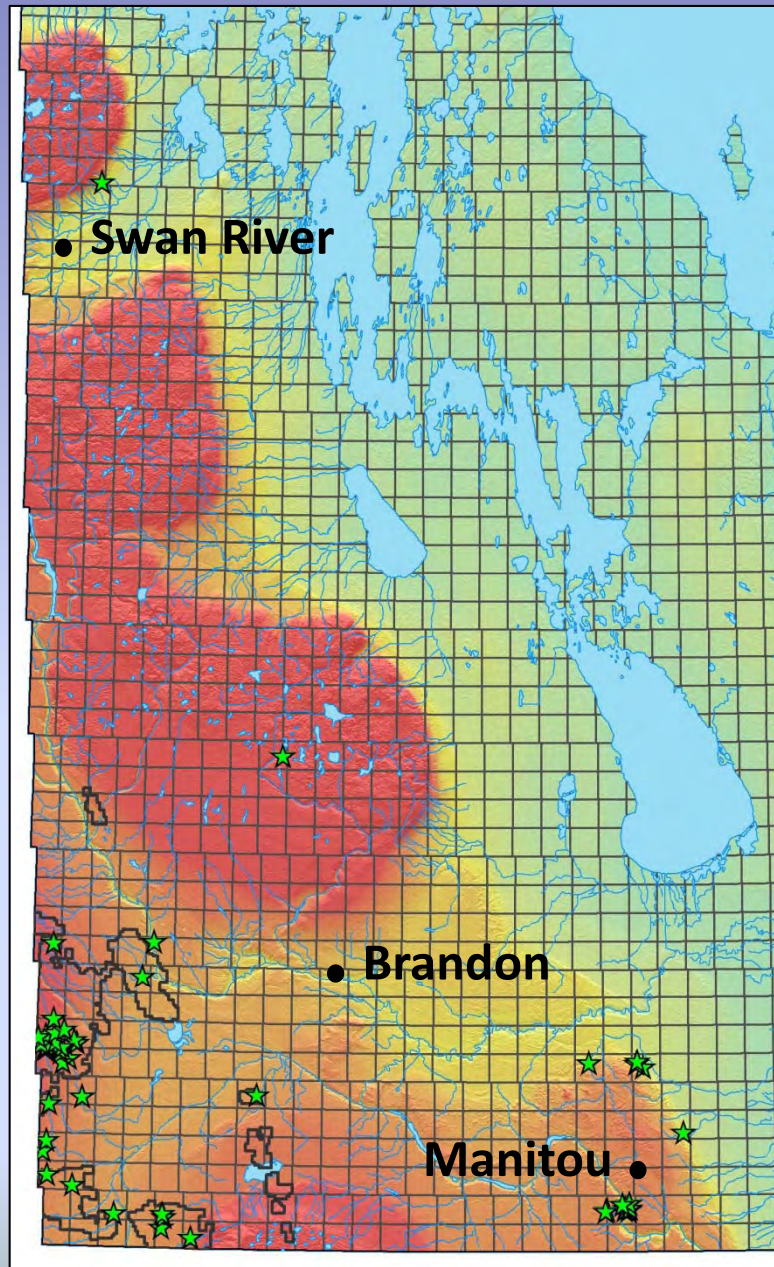
## Project goals:

- To verify if the Cretaceous sequences of SW Manitoba have the right **geological conditions** for economic shale gas accumulations.
- Identify the best target formations.
- Determine type of gas (biogenic or thermogenic).

# Cretaceous Gas Shows

1906-1933:

- Natural gas used for domestic lighting and cooking purposes at several sites in SW Manitoba.
- Historical documents indicate up to 12 gas wells drilled in SW Manitoba between 1906 and 1933.
  - least two wells remain capped.
- Exploration resumed between 2003-2006.



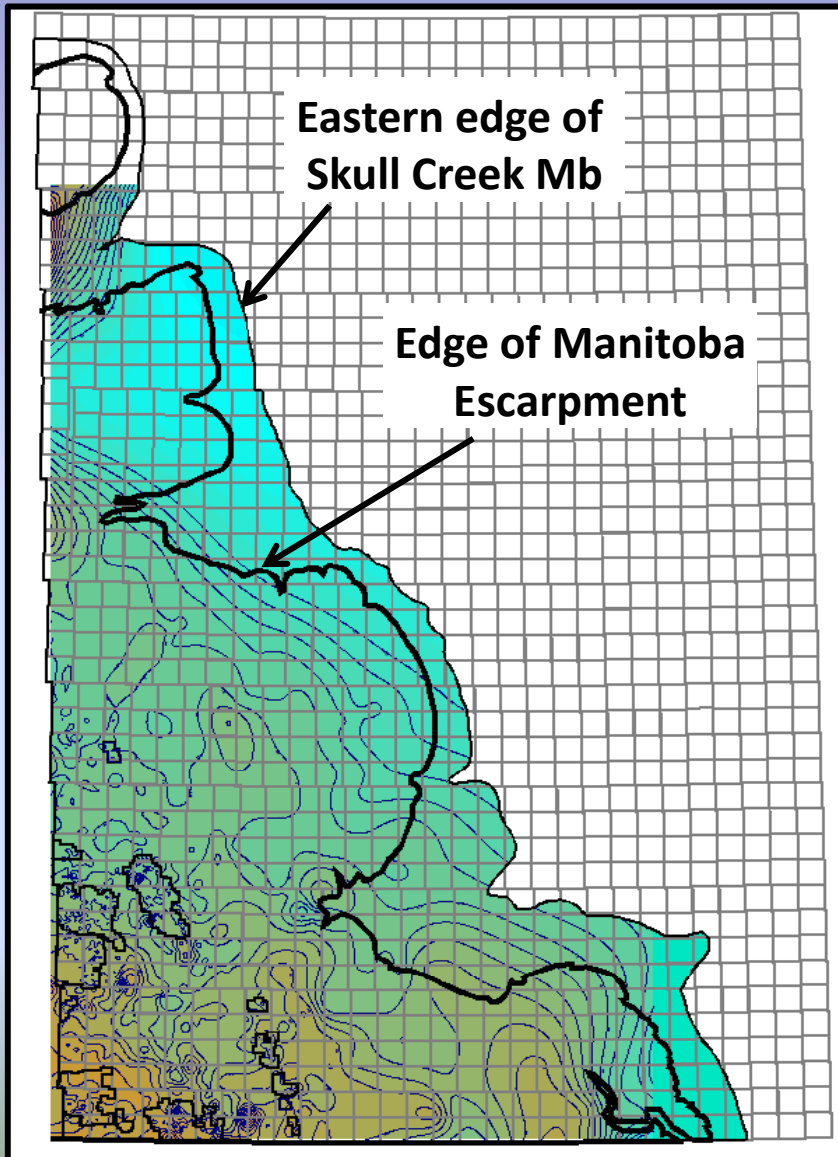
# Project Target Formations & Documented Gas Shows

SOUTHWESTERN MANITOBA			
CRETACEOUS	Pierre Shale	Coulter Member	
		Odanah Member	
		Millwood Member	
		Pembina Member	
		Gammon Ferruginous Member	
	Carlile Formation	Boyne Member	
		Morden Member	
	Favel Formation	Assiniboine Member	
		Keld Member	
	Ashville Formation	Belle Fourche Member	
		Westgate Member	
		Newcastle Member	
		Skull Creek Member	

*Yellow highlight indicates units with documented gas shows*

- Stratigraphic details:
  - West (T1 R29W1):
    - **620 m thick**
    - 100 m TVD to 720 m TVD
    - Pierre Shale (Odanah Mb) to Ashville Fm.
  - East (T2 R9W1):
    - **220 m thick**
    - 100 m TVD to 310 m TVD
    - Pierre Shale (Odanah Mb) to Ashville Fm.

# Isopach map: Pembina Member to Belle Fourche Member

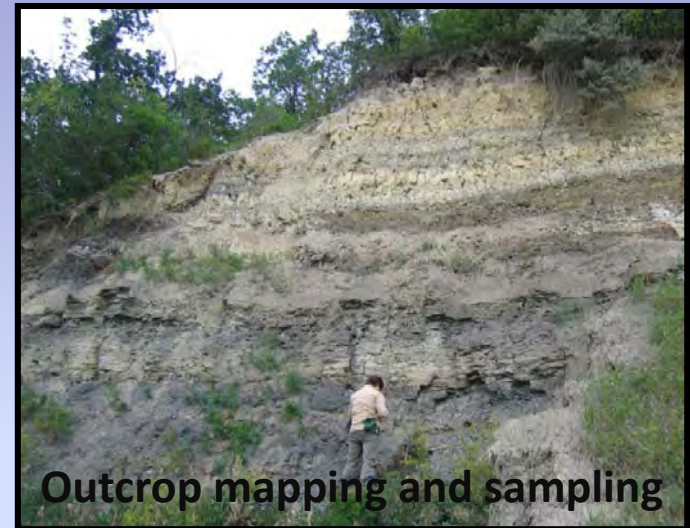


- Combined thickness of from the Pembina Member to the base of the Belle Fourche Member.
- Lack of data towards the north and along the outcrop belt.
- **Orange** upper limit = 240 m
- **blue** lower limit = 0 m

Contour interval = 10 m

# Outcrop, Core & Soil Sampling

- Geochemical and mineralogical analyses include:
  - Rock-Eval<sup>TM</sup> (TOC and  $T_{max}$ );
  - X-Ray Diffraction (XRD);
  - Major and minor trace element bulk geochemistry (chemostratigraphy).
- MMI - soil geochemistry profiling.
- SEM to characterize pores and estimate porosity.



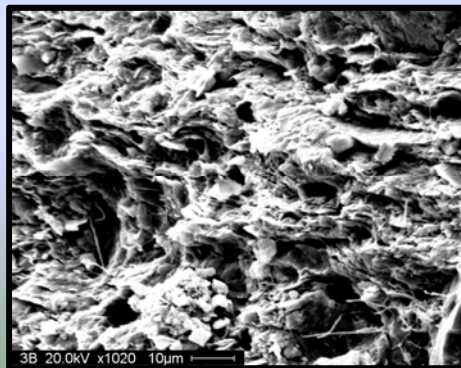
# Water and Gas Well Sampling

- Geochemical analyses include:
  - Dissolved gas composition;
  - Free gas composition;
  - Water chemistry:
    - cations, anions, alkalinity, sulphates;
  - Stable Isotopes:
    - Sulphur, carbon, oxygen.
- 5 free gas samples collected:
  - 2 gas wells;
  - 3 domestic water wells.
- 13 domestic water wells sampled.



# Results

- Geochemistry:
  - High organic content in the shale in most of the formations.
  - Rocks thermally immature, so gas is still present in the rocks.
  - Methane present is present as free gas within the pores, fractures and adsorbed on particles.
  - Dry biogenic gas.
- Mineralogy is complex and variable, but some beds have high quartz content.
- Porosity and permeability is comparable to the other shale gas plays.

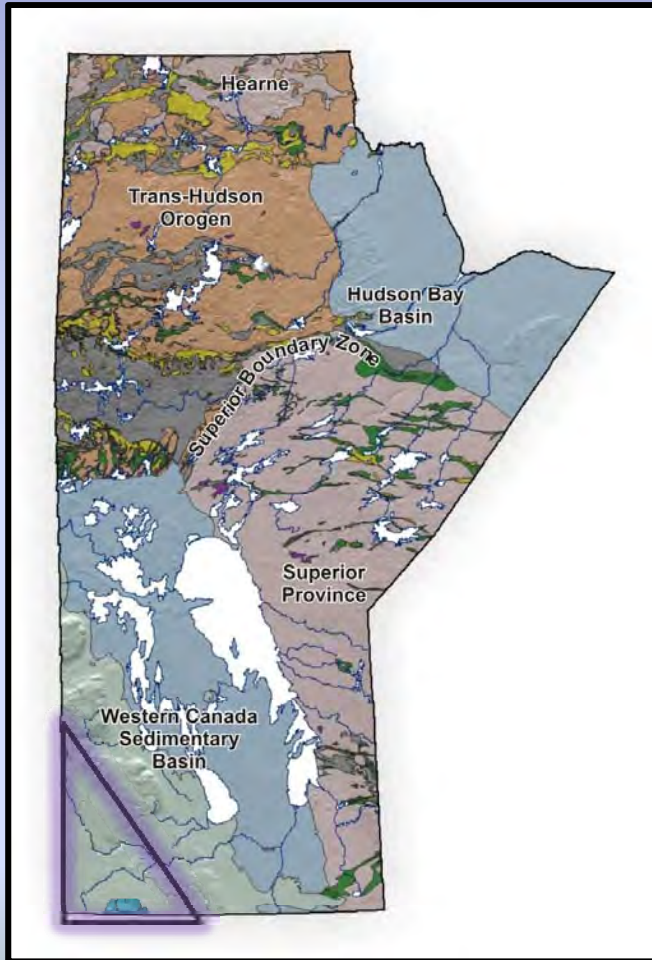


*SEM image of siltstone in the Carlile Formation showing pores.*

# Conclusions

- Best shale gas target formations identified include up to 220 m thick of shale.
- Geochemistry and mineralogy of the rocks is similar to other shale gas basins.
- Geochemistry results indicate that this is an unconventional **biogenic** shallow gas play.
- Potential shale gas area covers over 50 000 km<sup>2</sup>.
- Manitoba does have the right geological conditions for shale gas.
  - Question: Is it economic? .....
- ***Still more work to do...***

# Bakken-Three Forks Project

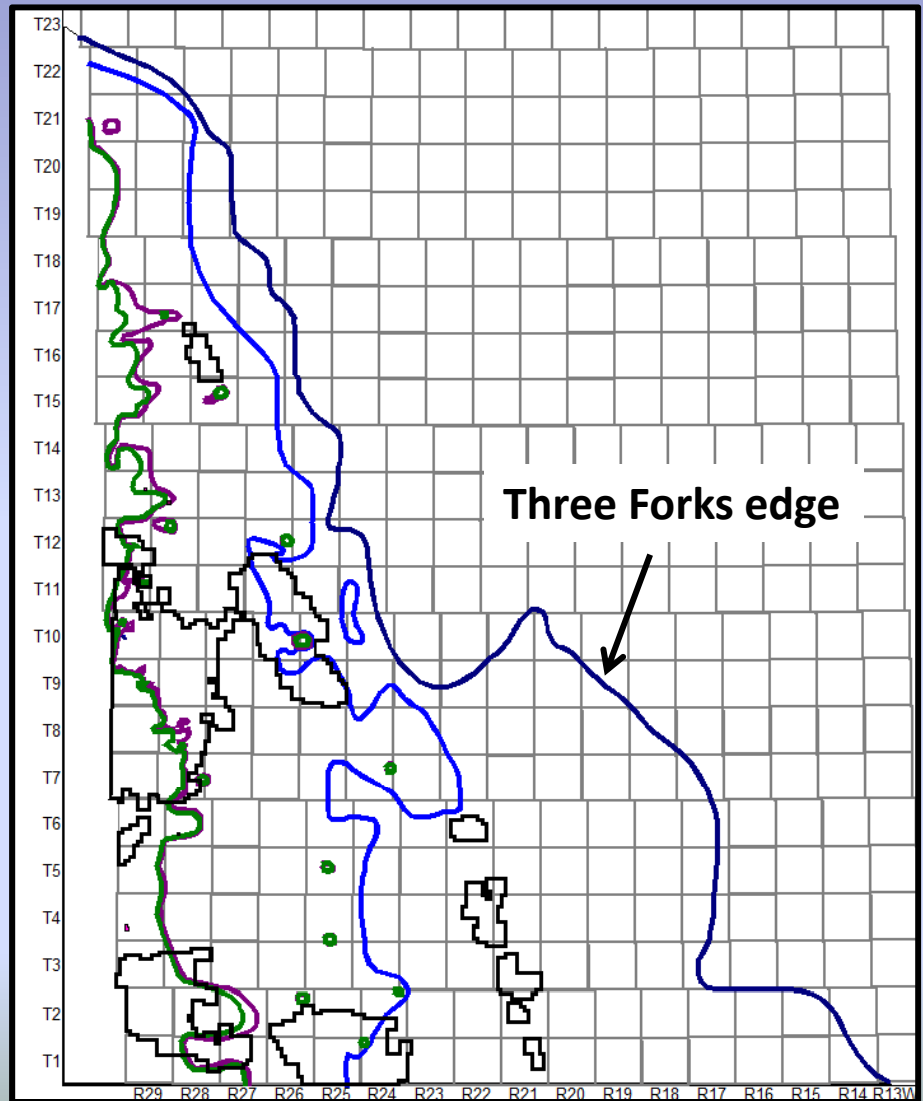


## Project goals:

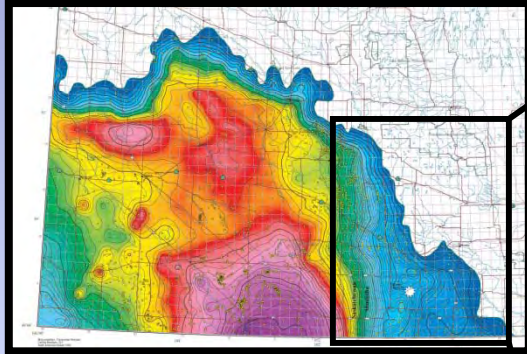
- Review, update and describe the stratigraphy of the Three Forks Fm.
- Describe the regional geology of the Three Forks Fm, and how it relates hydrocarbon accumulations.
- Update Bakken Formation stratigraphy and how it relates to the Three Forks Fm.
- Define the Big Valley Formation.
- Build a depositional, erosional and deformational model for the Three Forks, Big Valley and Bakken formations.

# Three Forks Formation

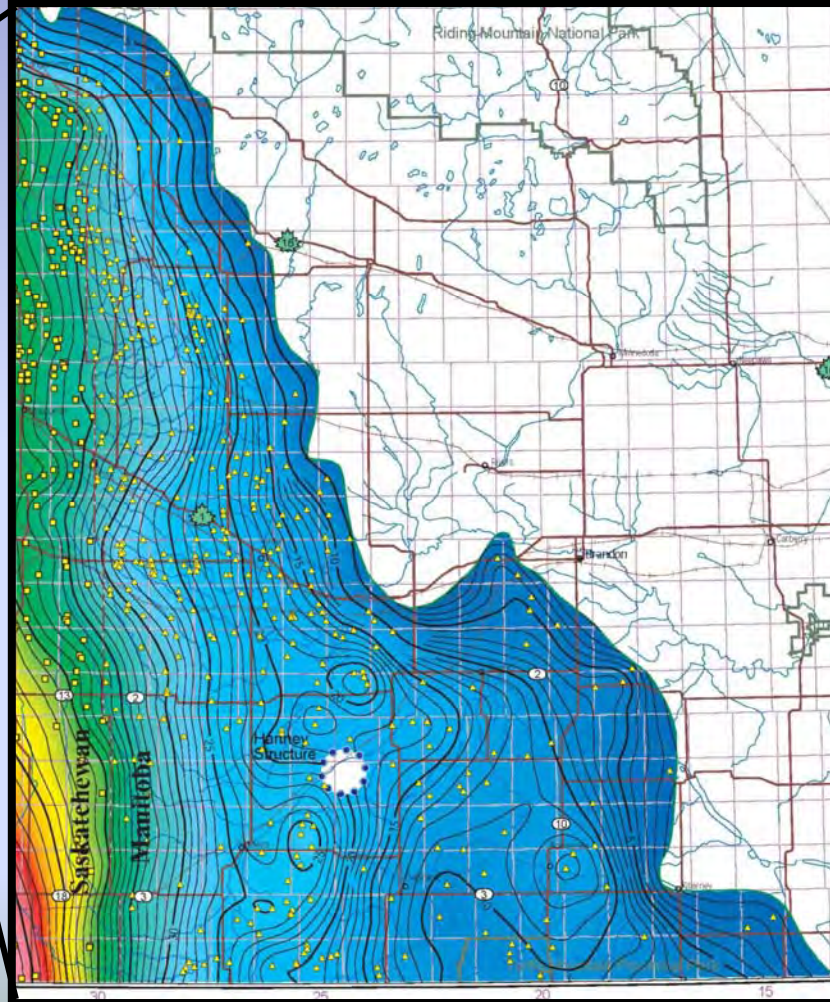
- Maximum thickness of the Three Forks in Manitoba is 64 m.
- Three Forks is subdivided into four units;
  - Correlative to Christopher (1961) units in Saskatchewan.
  - Units 1, 2 and 4 are further subdivided into subunits.
- Isopach and subcrop trends of each unit are north-south.
- Three Forks and Middle Bakken are hydraulically linked, therefore oil production is reported as commingled.
- Best production comes from subunit 4c, and subunit 2c.
- Where there is production from Unit 4, the Middle Bakken is very thin (< 1m).
- Production from Unit 2 is economic when the Middle Bakken is thick (> 4 m) and acts as the dominant reservoir.



# Three Forks Isopach

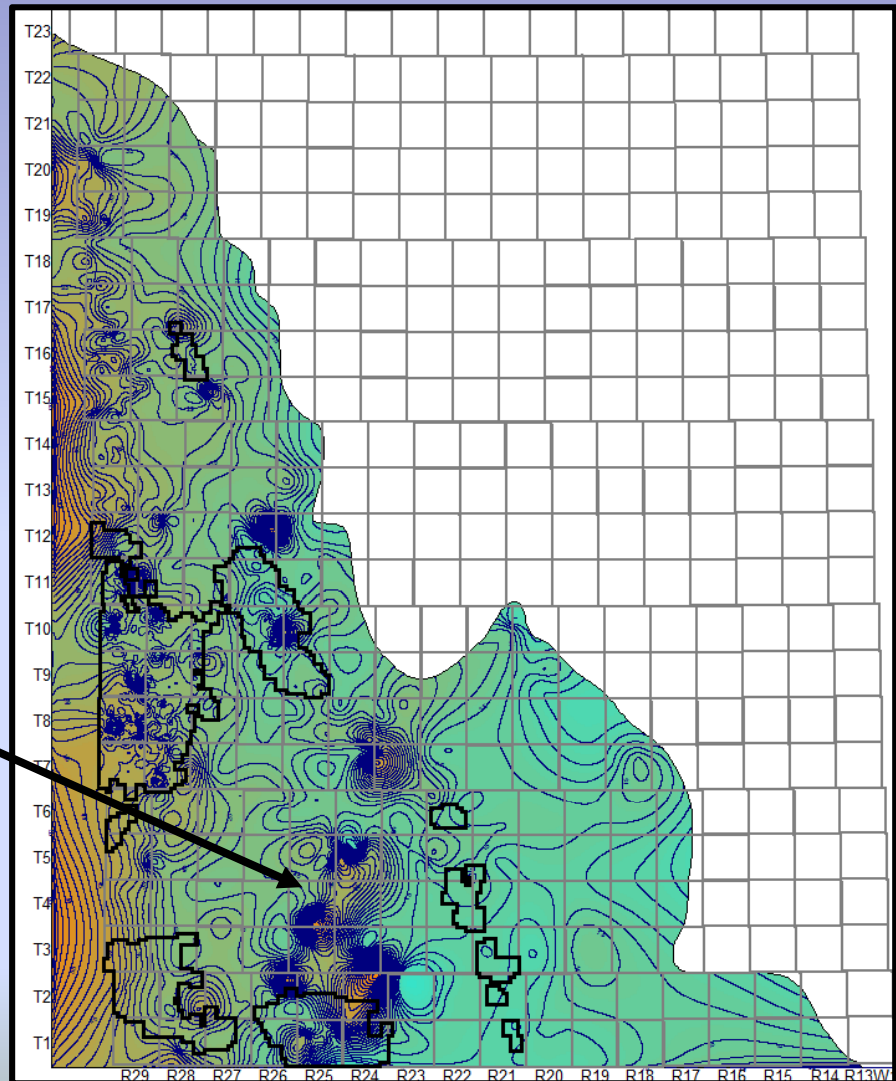


- Thin in Manitoba due to erosion
- Thickest in the west along the MB-SK border



# Three Forks Isopach

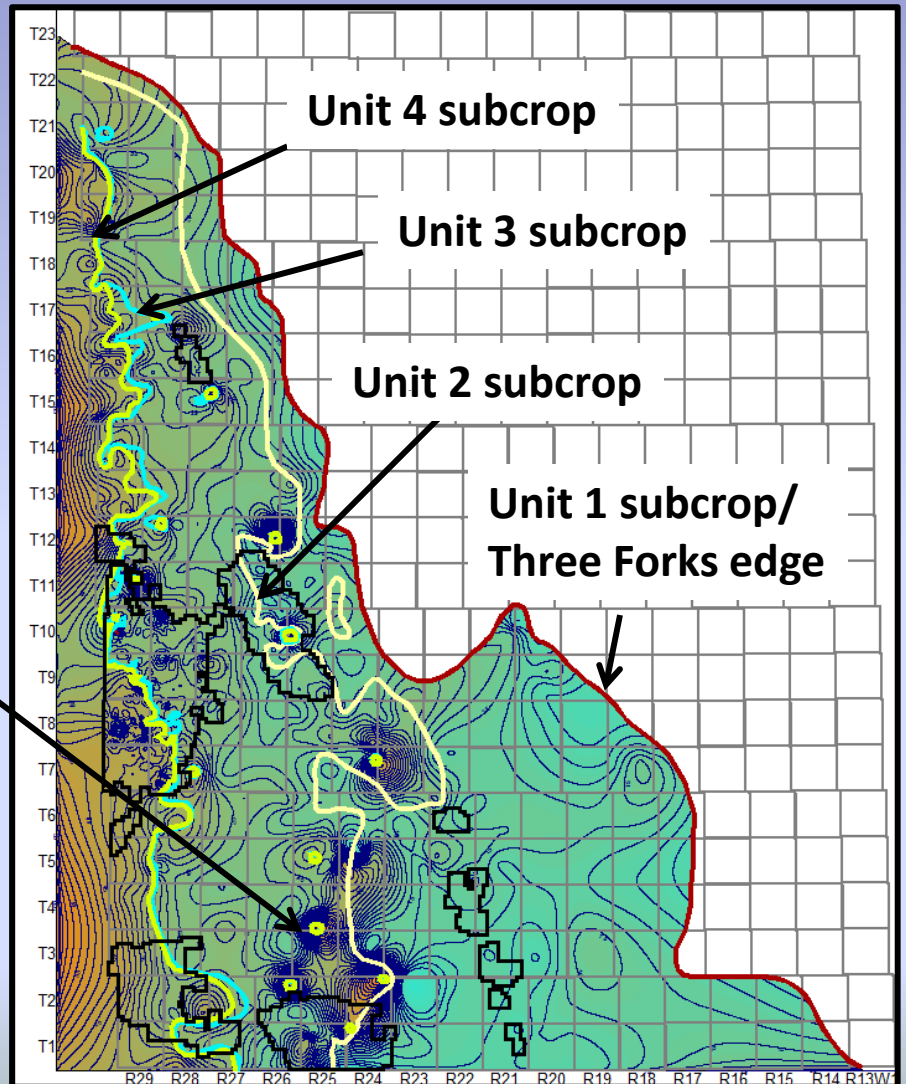
- Thickest in the west along the MB-SK border
- Localized thickening in the east



Contour Interval = 2 m

# Three Forks Isopach & Unit Edges

- The units within the Three Forks were individually mapped.
- North-south trend to subcrop edges; follows isopach trend.
- Localized isopach thicks in the east correspond to preservation of Units 3 and 4 east of the main subcrop edge for these units.



Contour Interval = 2 m

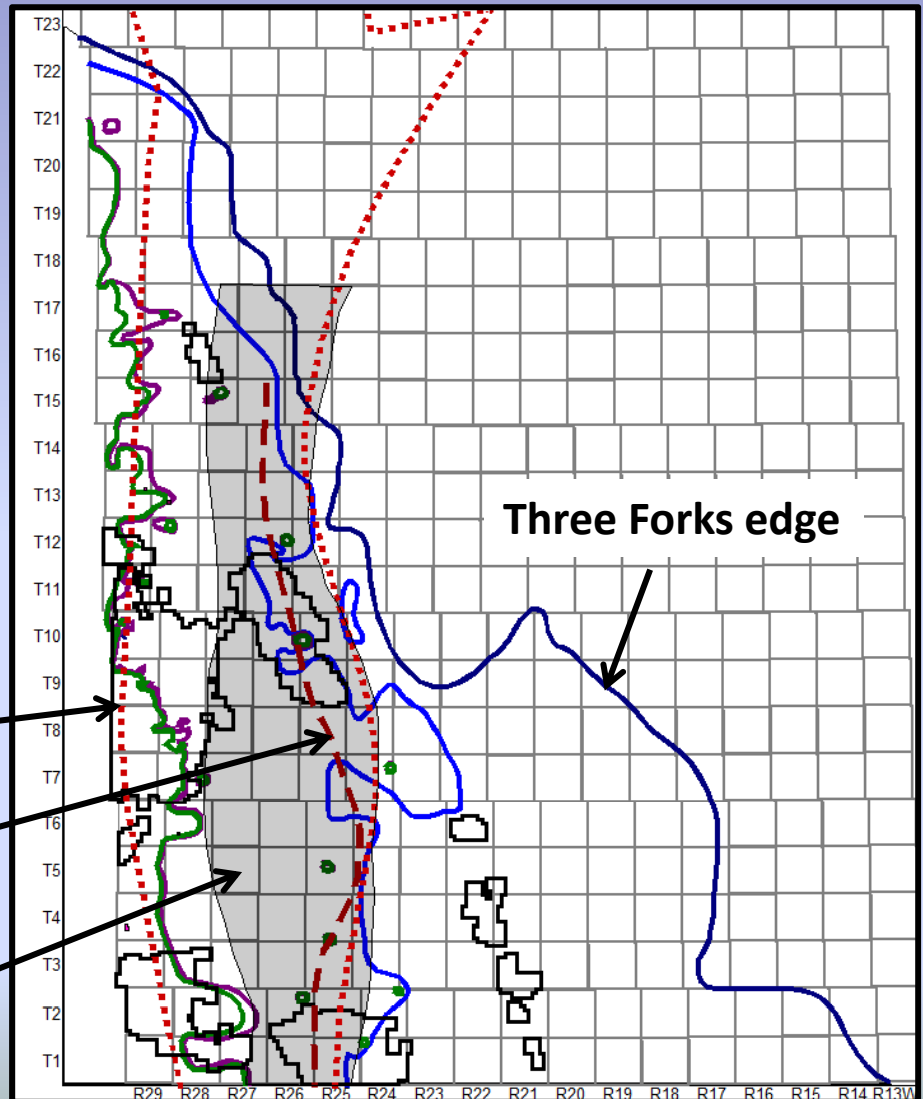
# TF Unit Edges & Tectonics Controls

- Basement features:
  - Fault re-activation throughout the Paleozoic (SBZ);
  - Large scale effects of the Severn Arch.
- post-Prairie Evaporite structural deformation:
  - Localized and large scale salt collapse;
  - draping effects.

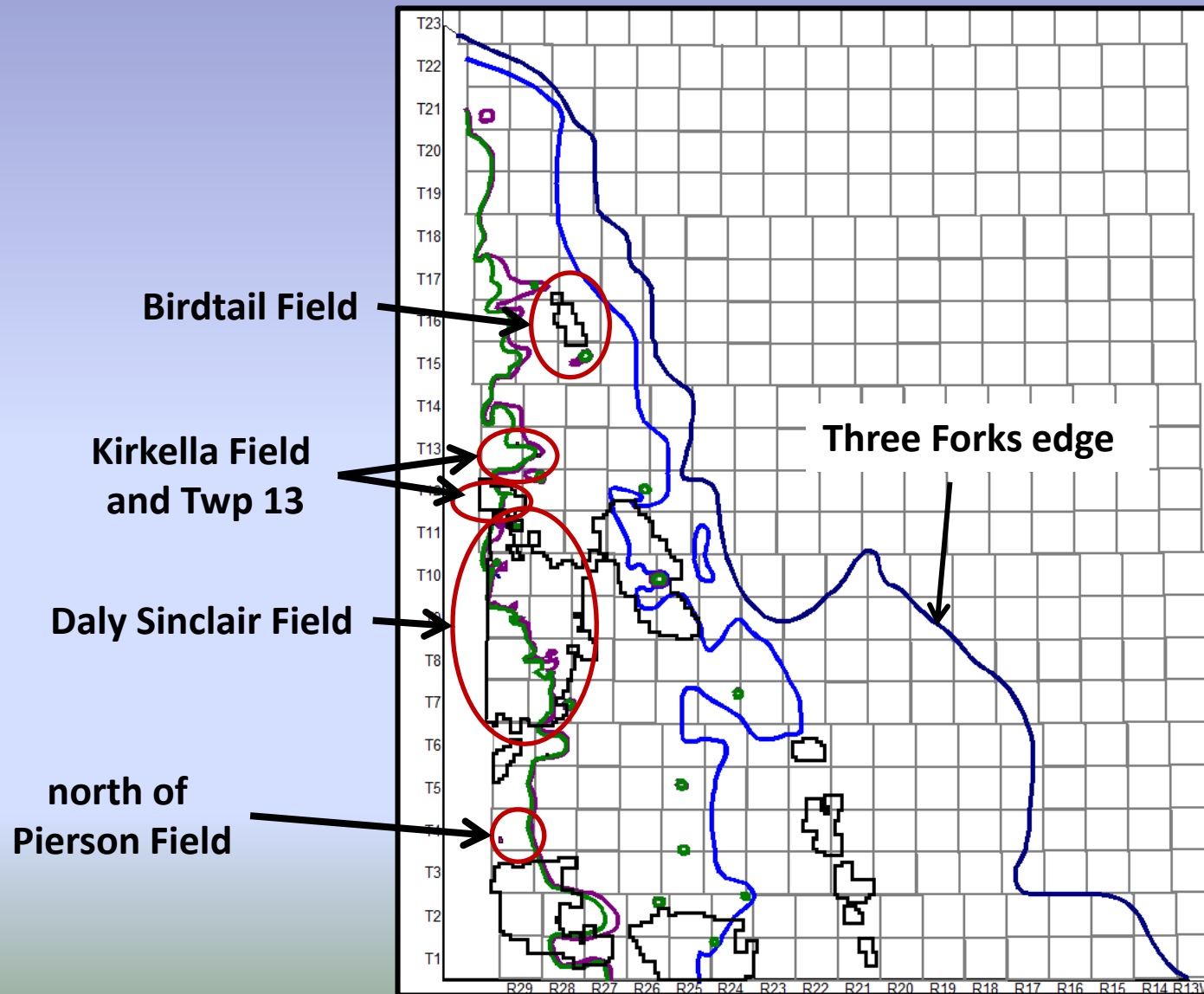
**Superior Boundary Zone**

**basement hinge line**

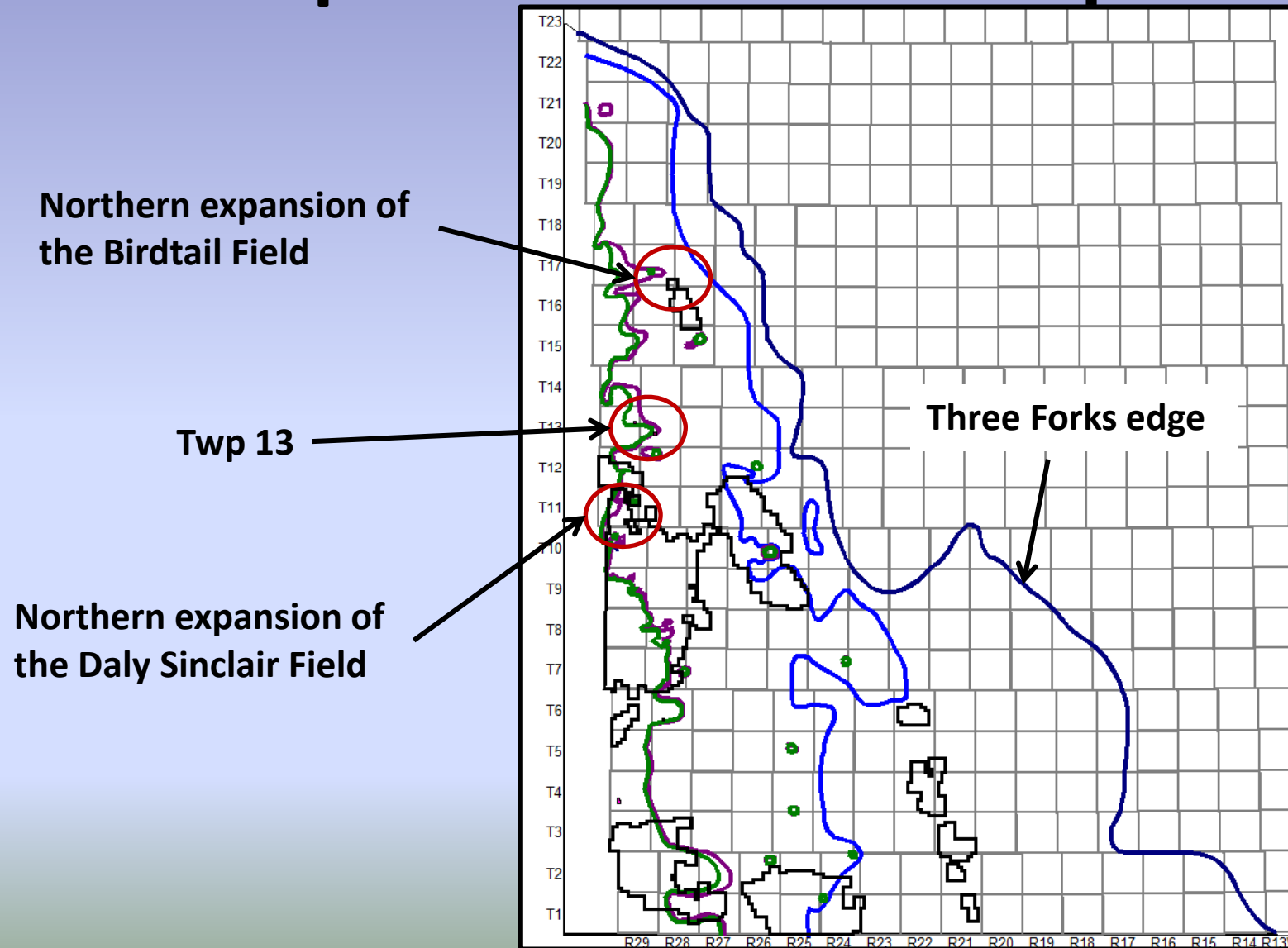
**Birdtail-Waskada Zone**



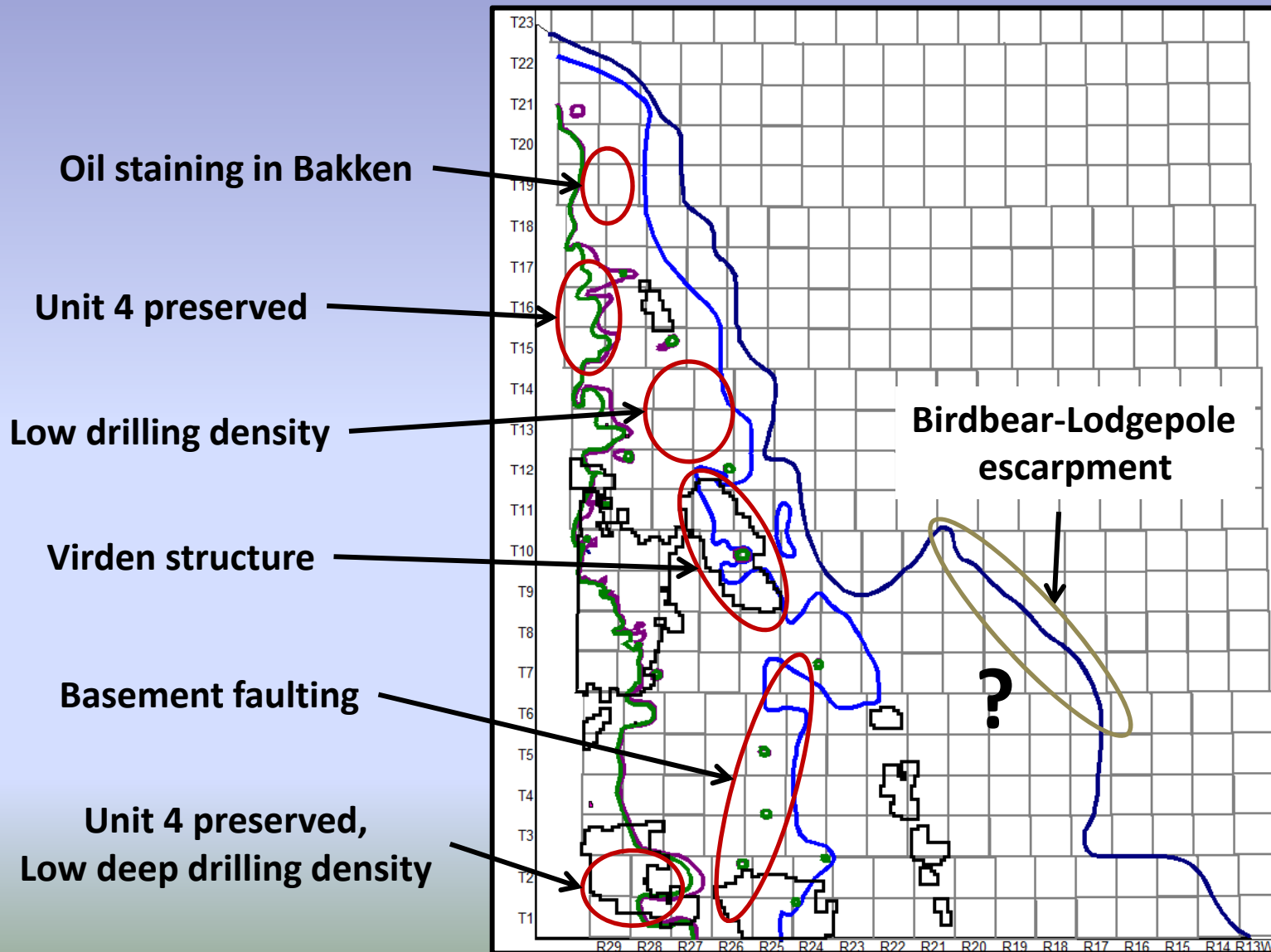
# Bakken-Three Forks Producing Areas



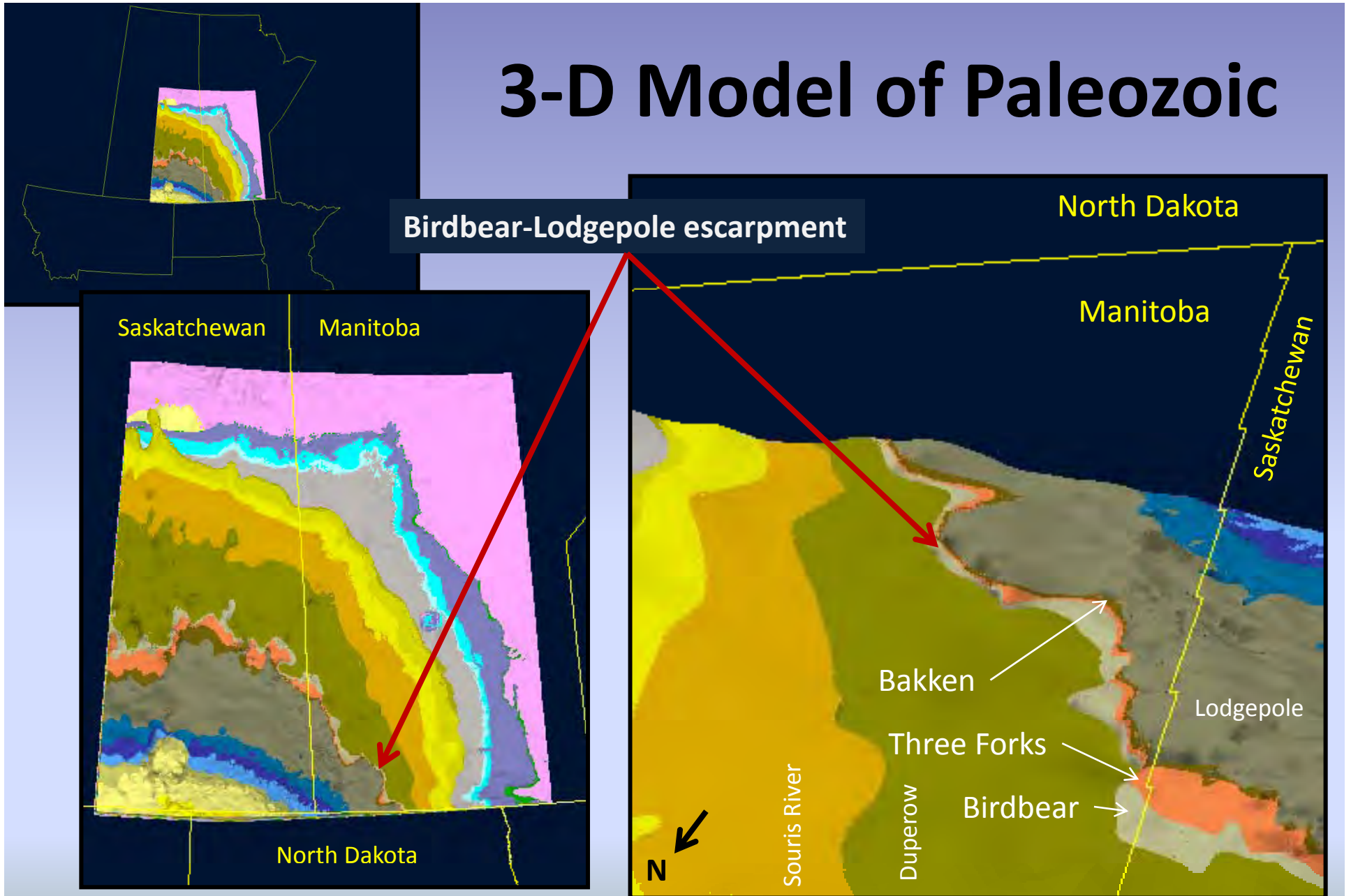
# Recent Bakken-Three Forks Exploration and Development



# Bakken-Three Forks Prospects

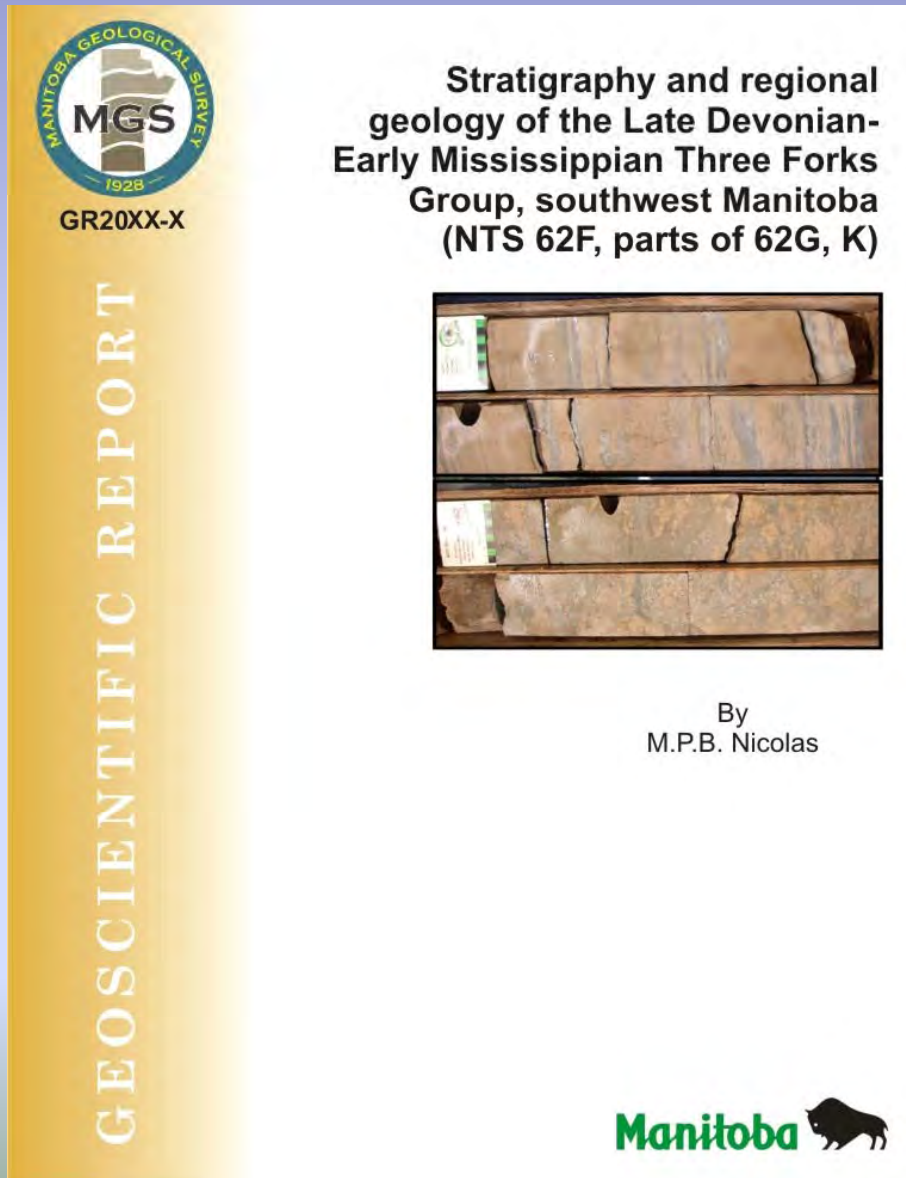


# 3-D Model of Paleozoic



From the TGI 2 Williston Basin 3-D Model  
(available at [www.WillistonTGI.com](http://www.WillistonTGI.com))

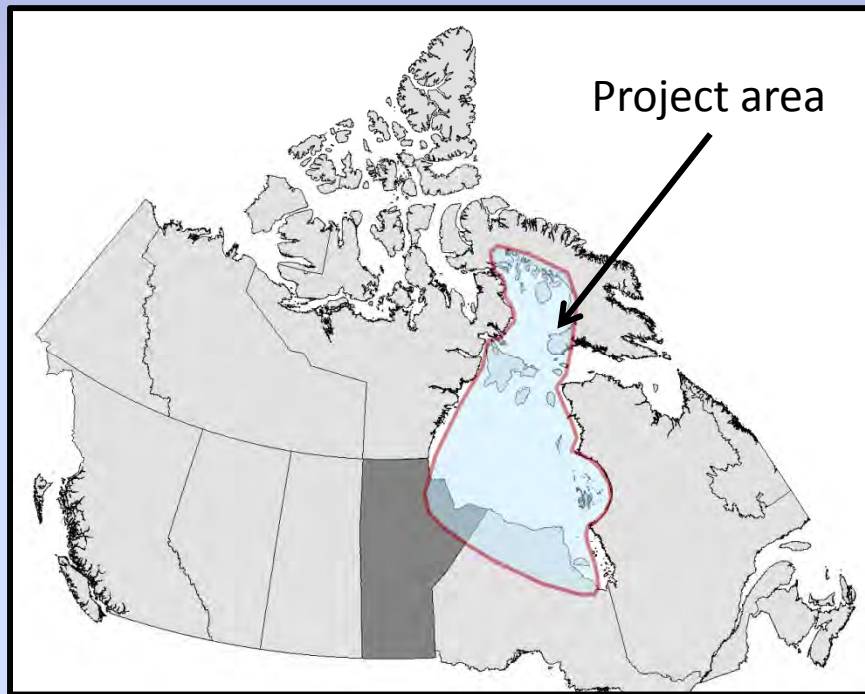
# Coming Soon...



## Geoscientific Report will include:

- New stratigraphic framework.
- Updated regional geological framework.
- Detailed description and mapping of the Three Forks, Big Valley and Bakken formations.
- Depositional, erosional and deformation model described.
- Economic discussion.

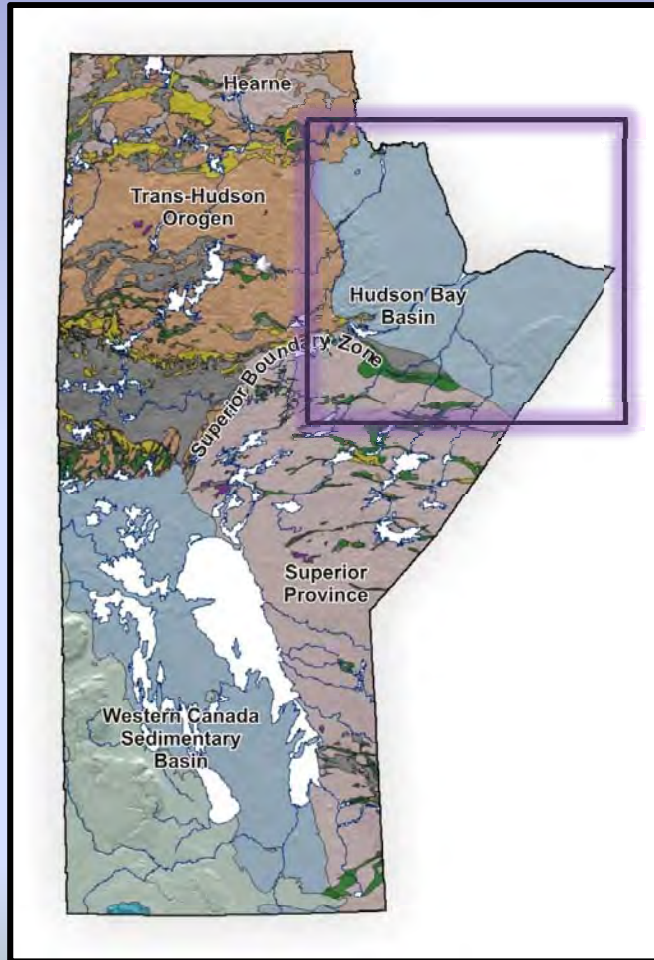
# GEM Energy: Hudson Bay and Foxe Basins Project



## Project goals:

- Develop a better understanding of the geological evolution of the basins;
- Provide a modern appraisal of their hydrocarbon potential.

# GEM Energy: Hudson Bay and Foxe Basins



## Results to date:

- Several oil shale horizons;
- Shale within the oil window.
- Bituminous residue found in several cores;
- Modern pockmarks identified on the basin floor.

**Still more work to do...**

# For more info on MGS projects...

Click on



at

# [www.manitoba.ca/minerals](http://www.manitoba.ca/minerals)