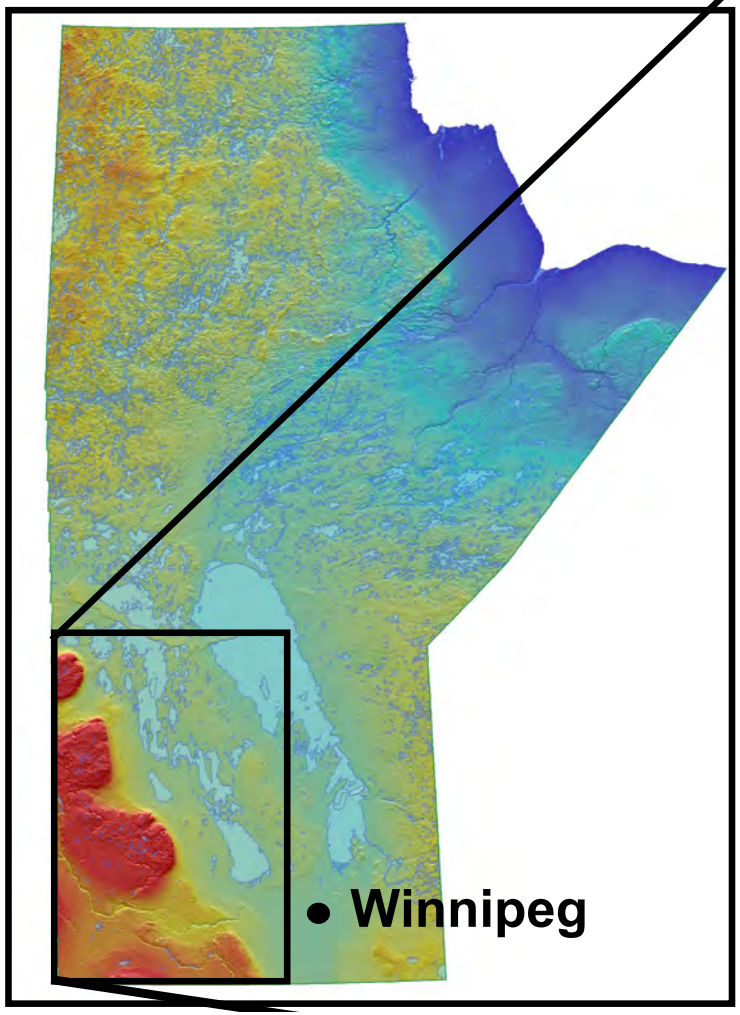
Cretaceous Shale Gas Prospects of Southwestern Manitoba: Preliminary Results

Michelle P.B. Nicolas
and
James D. Bamburak

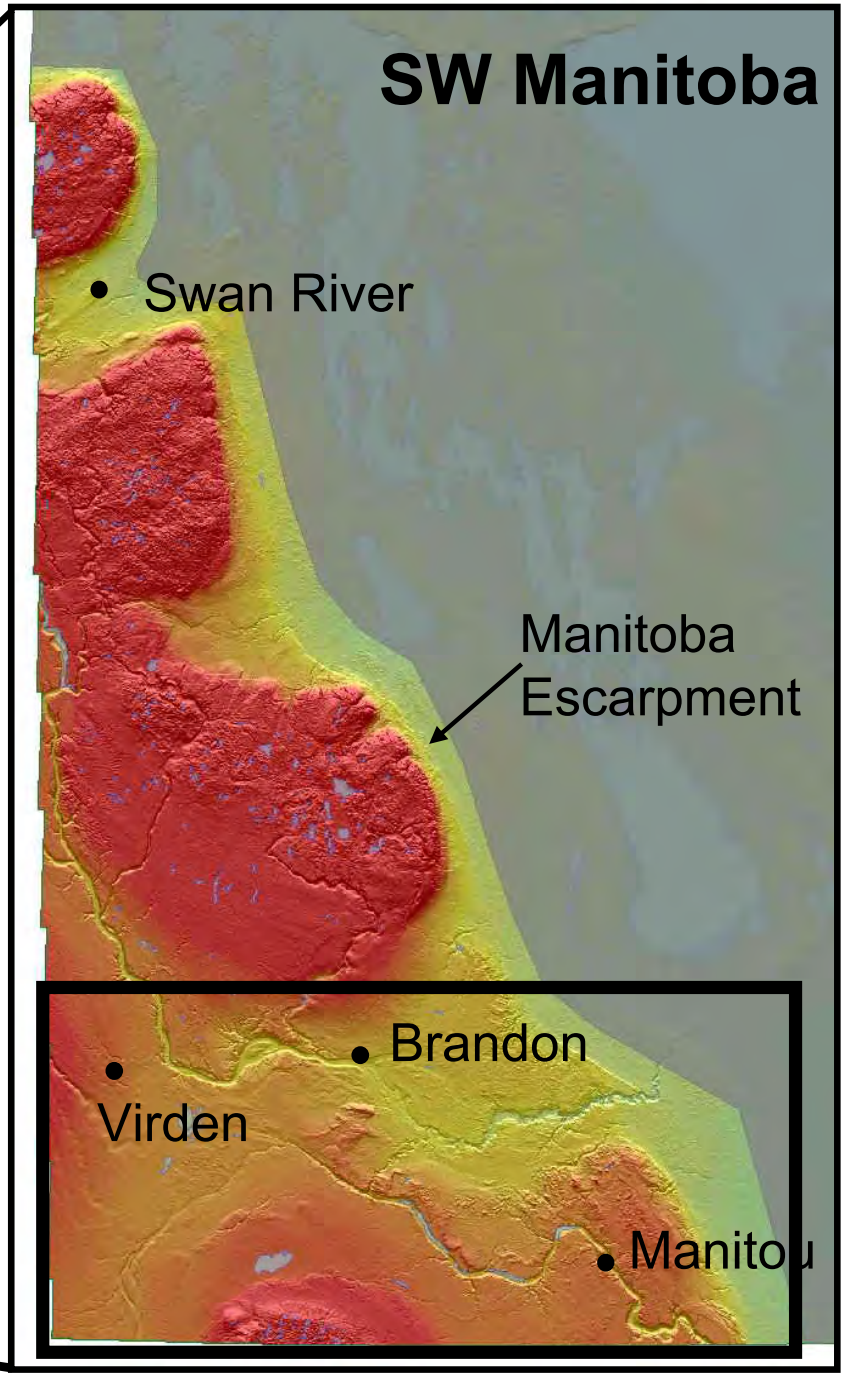
Manitoba Geological Survey
Winnipeg, Manitoba

Manitoba

Study Area



DEM of Manitoba, Canada



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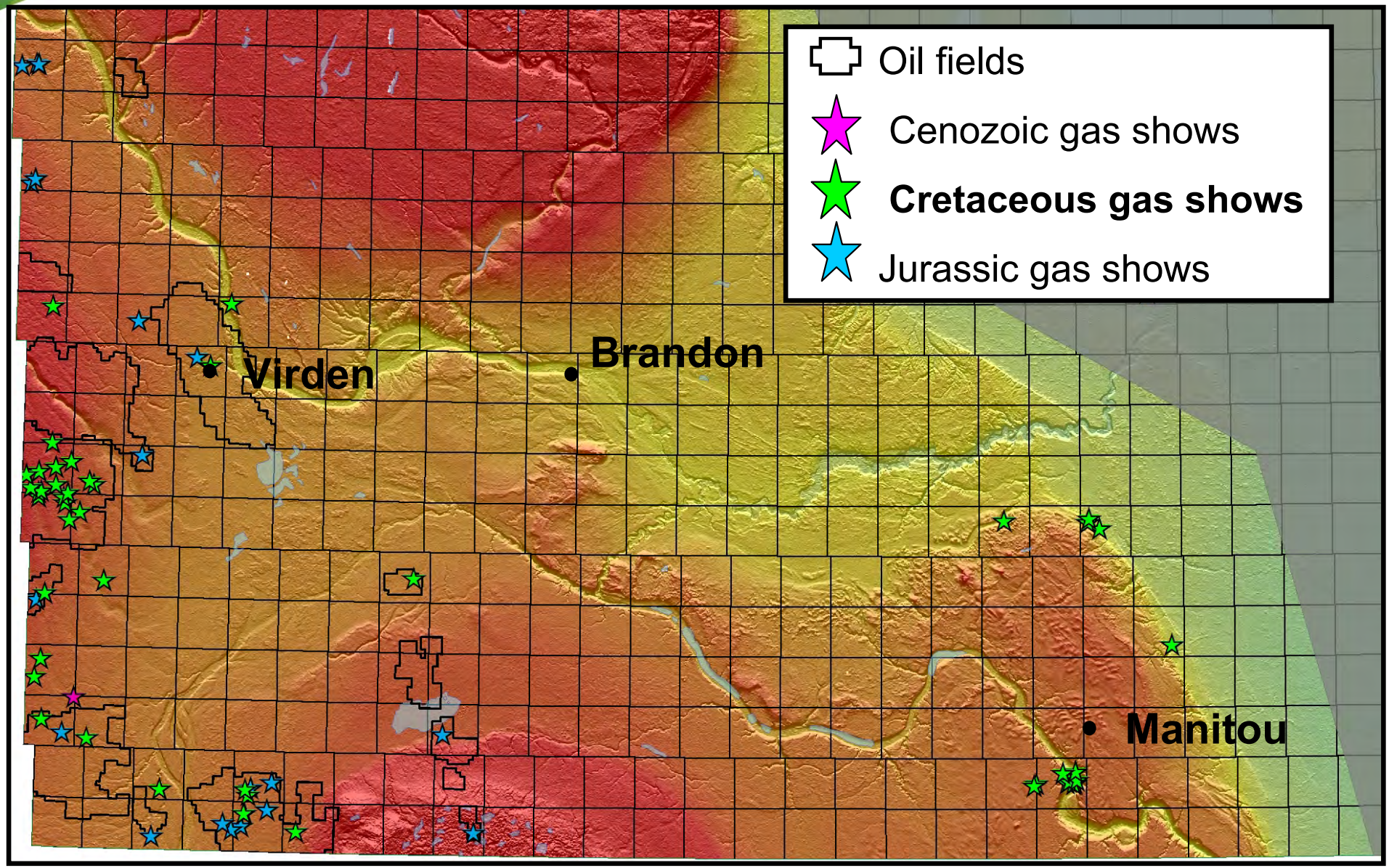
Mesozoic Gas Shows



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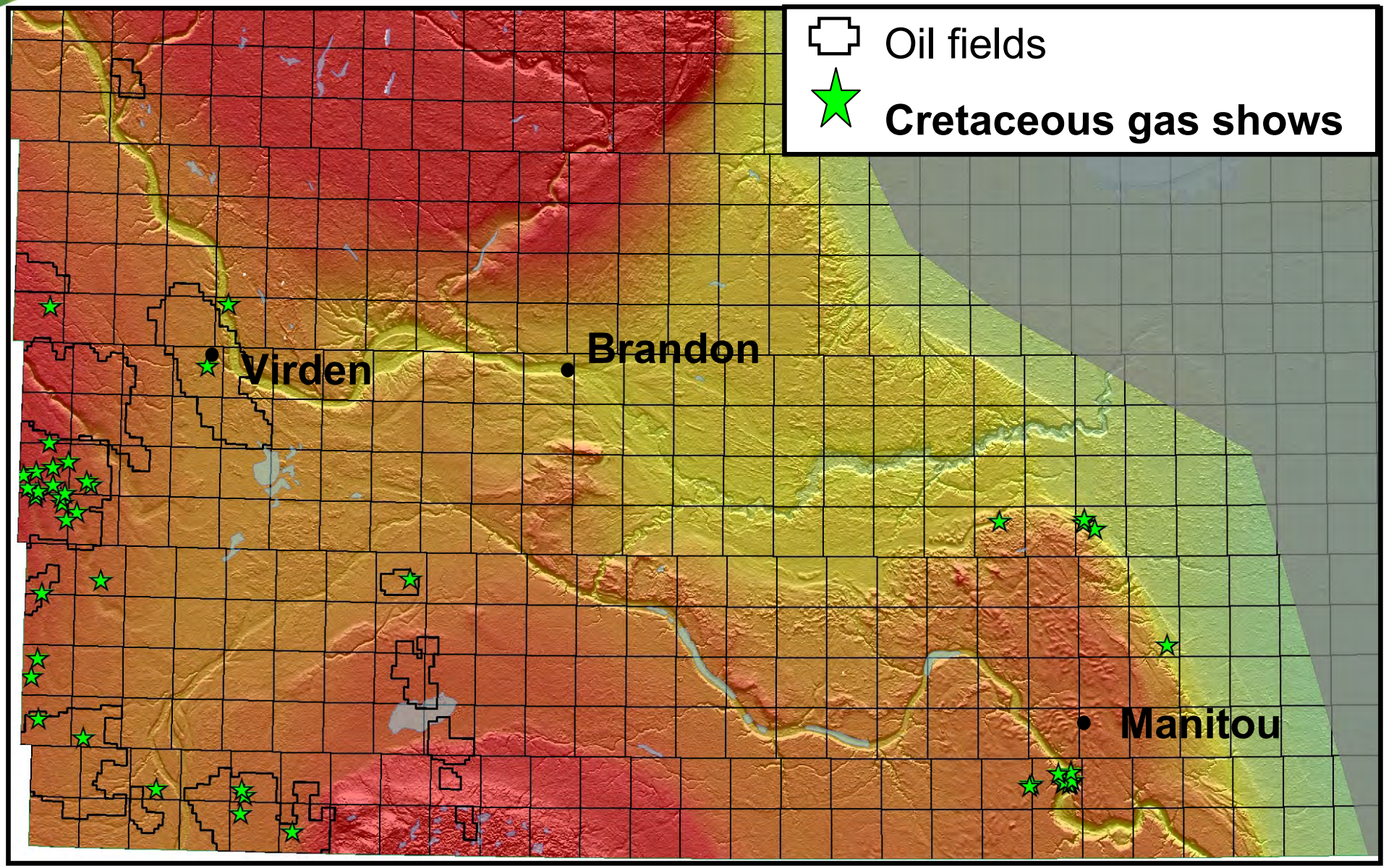
Cretaceous Gas Shows



Project Purpose

- Does Manitoba have the right geological conditions for economic shale gas production?
  - What are the best target formations?

- Is the gas biogenic or thermogenic?
  - If it's biogenic is it early-generation or late-generation?

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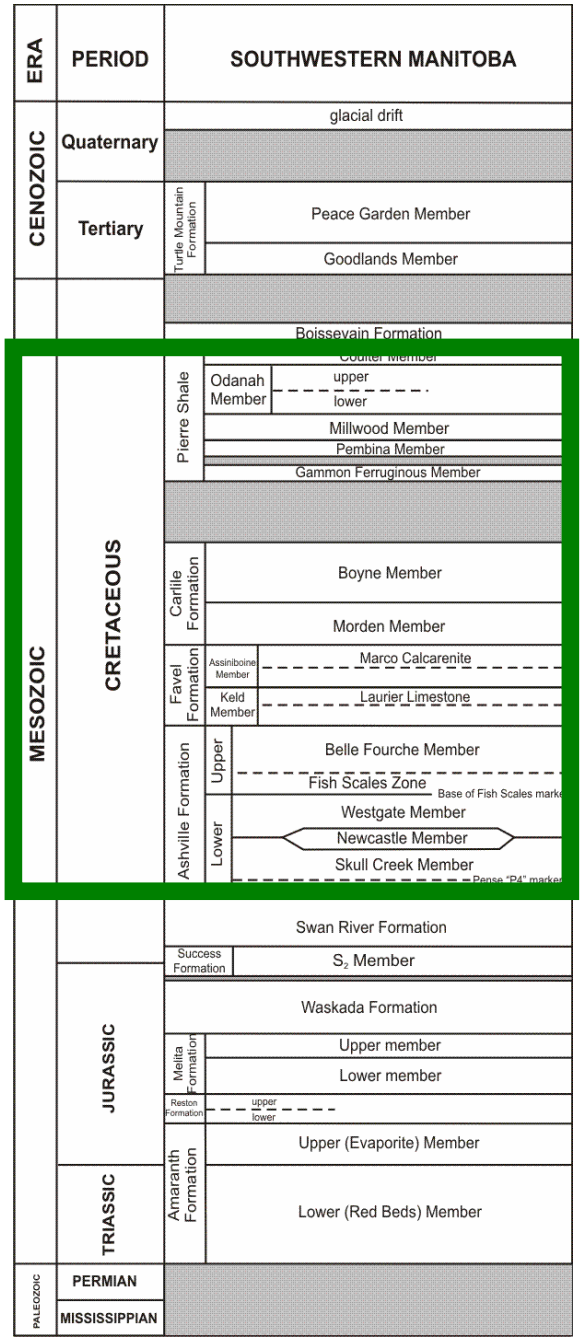
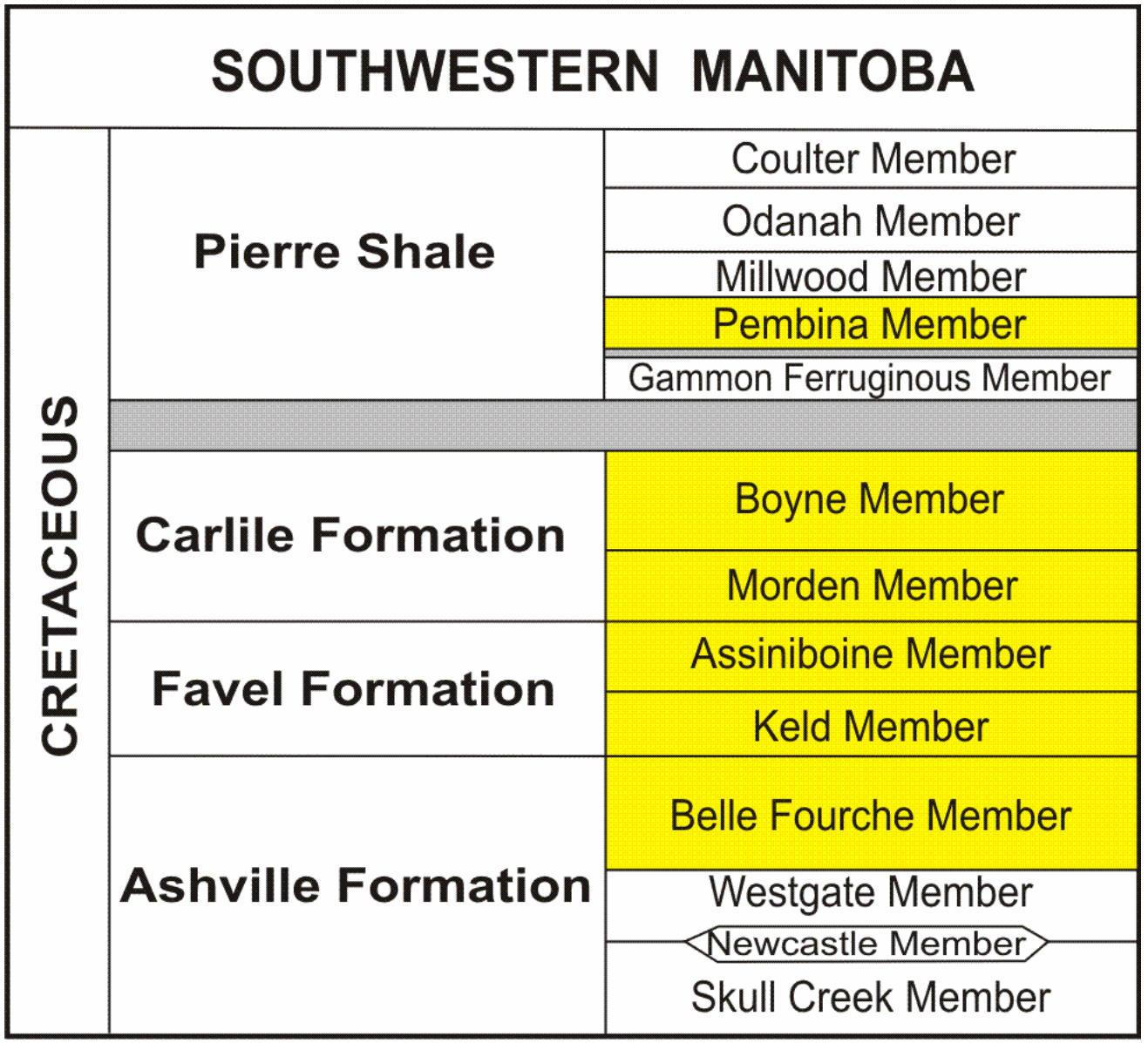


Upper Cretaceous

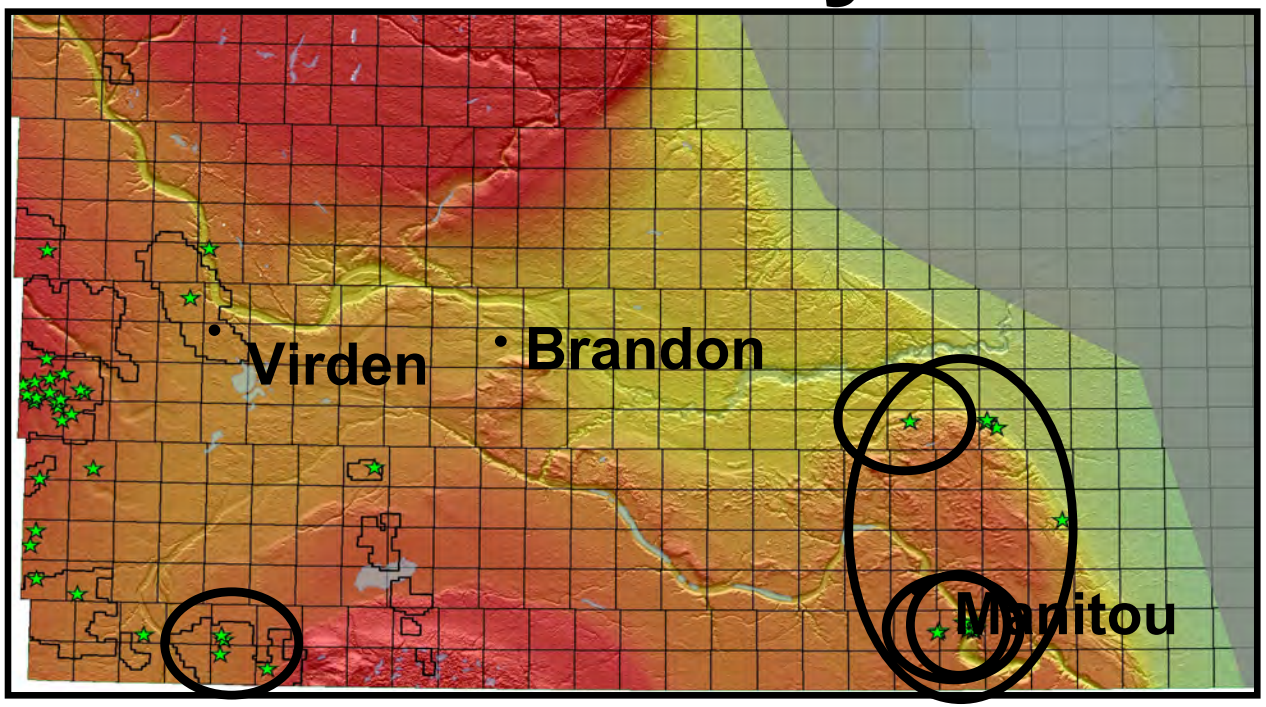
Project Target Formations

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

Documented Gas Shows



Exploration History: 1906-1933



- Wallace and Greer (1927) reported natural gas being 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.
- Most of these wells are now abandoned, but at least two wells remain capped.

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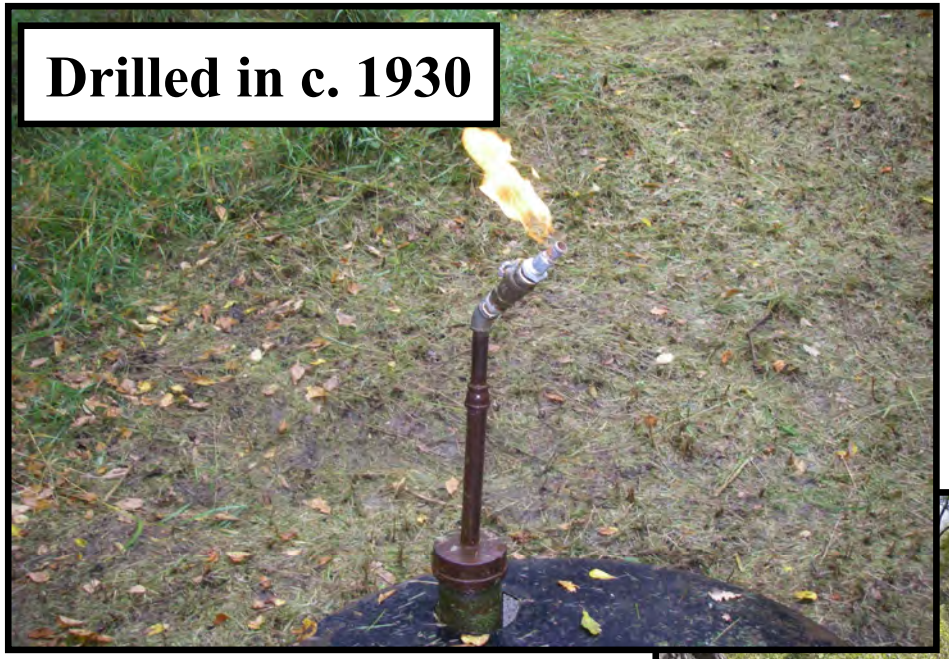
Exploration History: 1906-1933

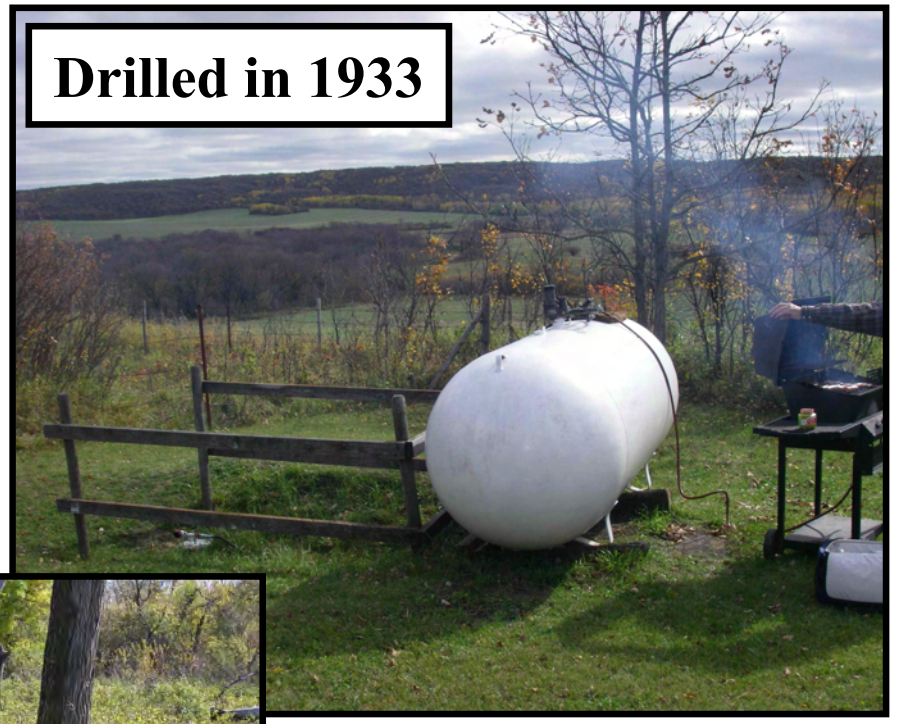
Two capped gas wells with pressures of ~ 276 kPa, near Manitou, Manitoba.

Exploration History: 1906-1933

Notre Dame de Lourdes, MB



221 kPa initial pressure



Manitou, MB

276 kPa initial pressures

Drilled in 1907
Well TVD: 396 m
Gas Depth: 183 m

Modern Exploration: 2003-2006

2003 to 2006: Waskada Field area, north of Pierson Field, and the Manitou area

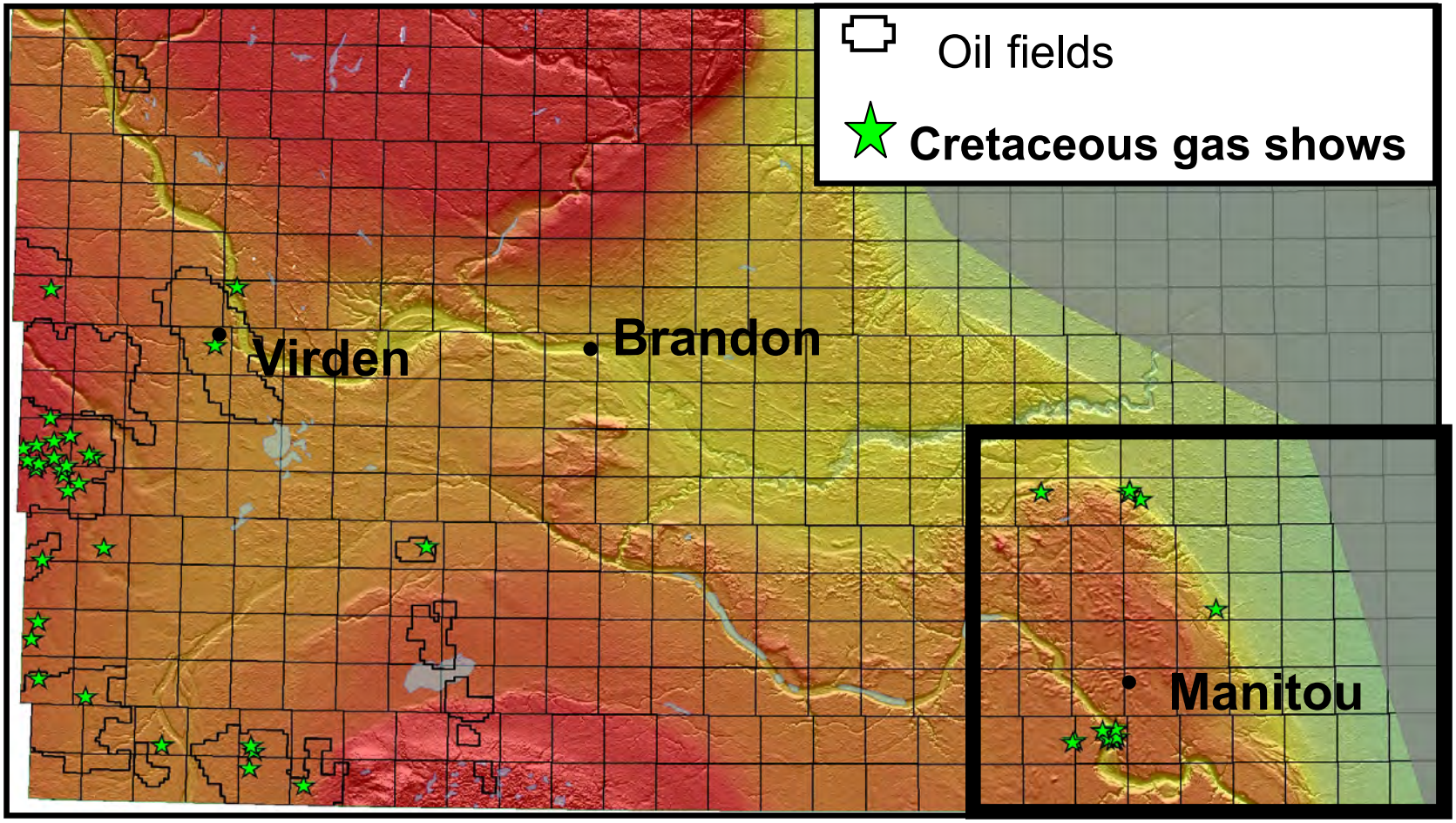
- 3 wells cased for production in the Favel Formation in the Waskada Field; now abandoned.
- 2 wells north of Pierson Field: cored, cased, stimulated.
- 1 well in Manitou area: cased, formation tested.

Outcrop and Core Sampling

- Geochemical and mineralogical analyses include:
  - Rock-Eval 6 ®
    - Including TOC and Tmax
  - X-Ray Diffraction (XRD)
  - Major and minor trace element bulk geochemistry (chemostratigraphy)

2008 Field Work

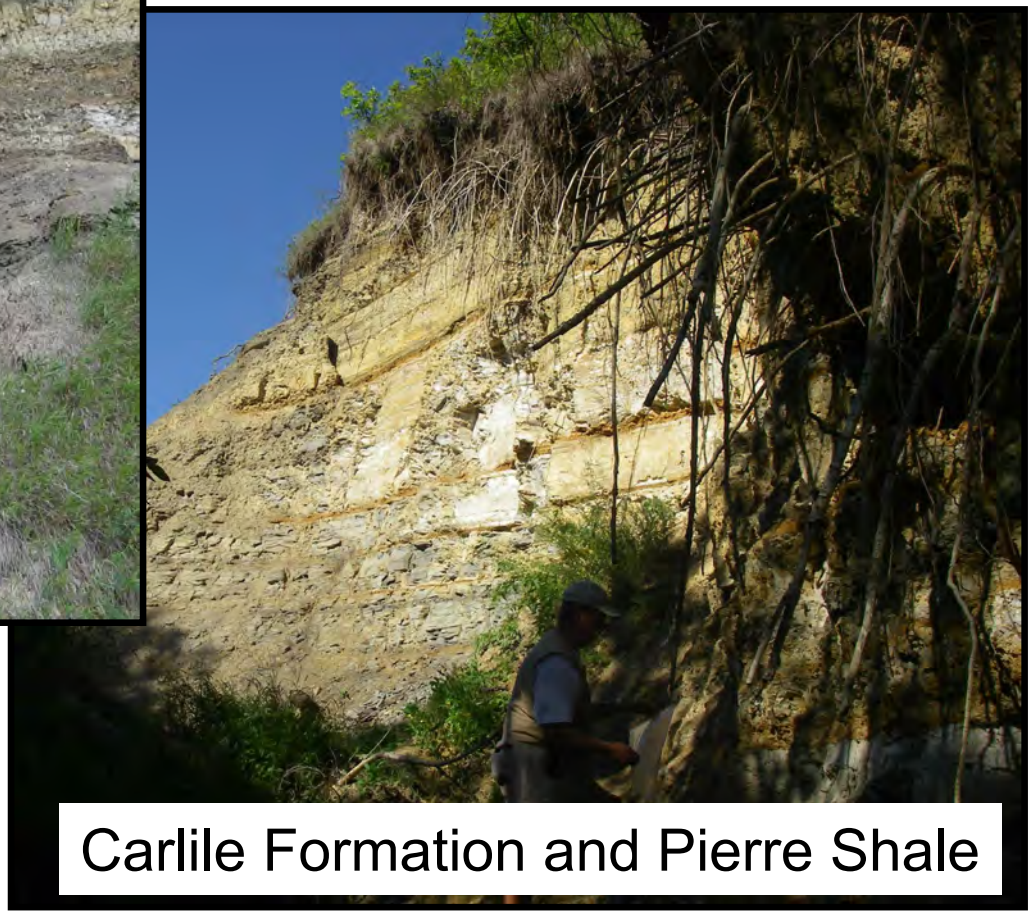
- Pembina Hills & Pembina Valley region



Outcrop Sampling 2008

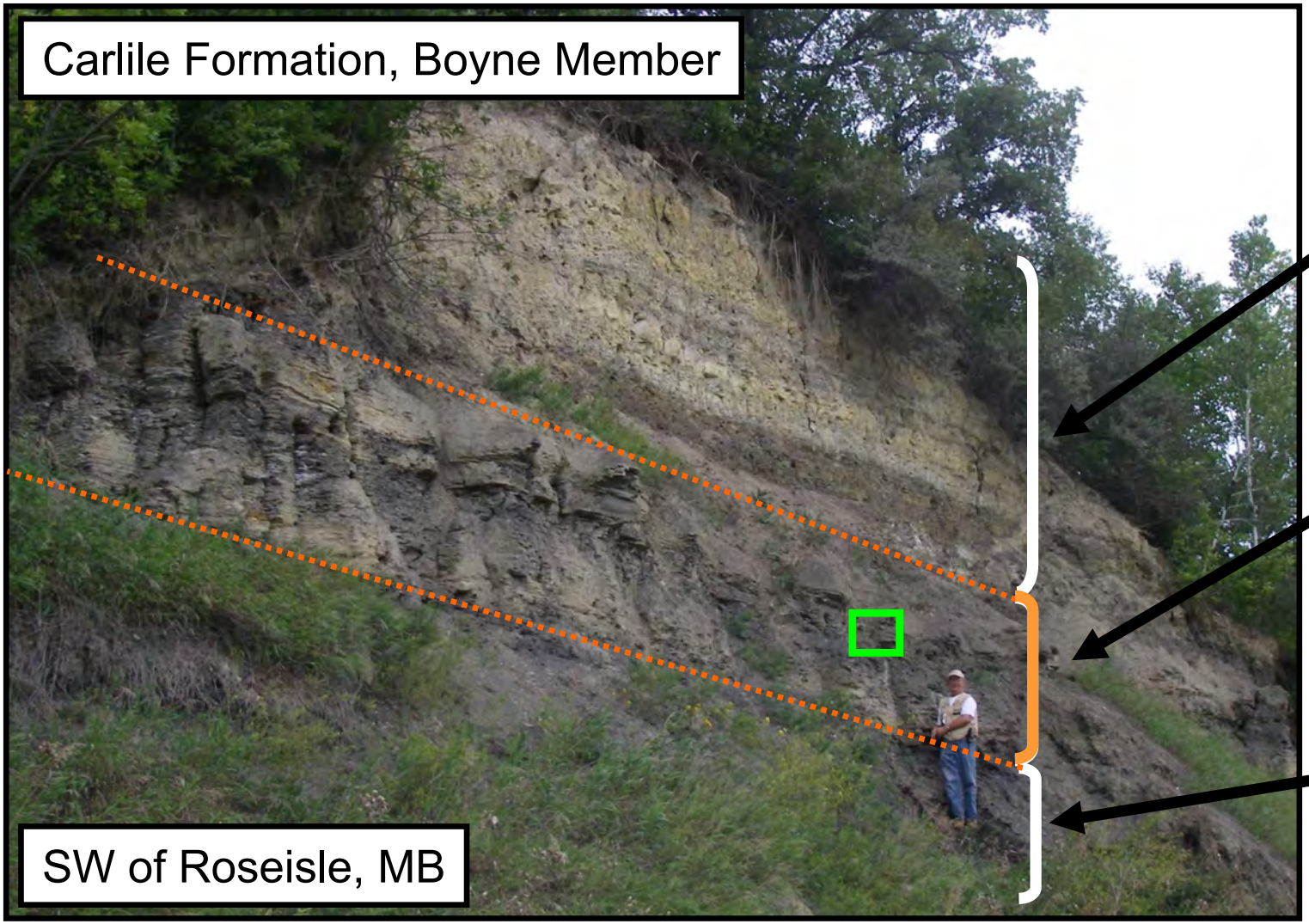

Carlile Formation

36 outcrop field stations examined and sampled.


Carlile Formation and Pierre Shale

The Favel Formation to Pierre Shale were sampled.

Field Work Highlights



Field Work Highlights

organic shaly siltstone with sandstone lenses

black organic shale

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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

Water and Gas Well Sampling 2008

- 13 domestic water wells sampled

5 free gas samples collected:

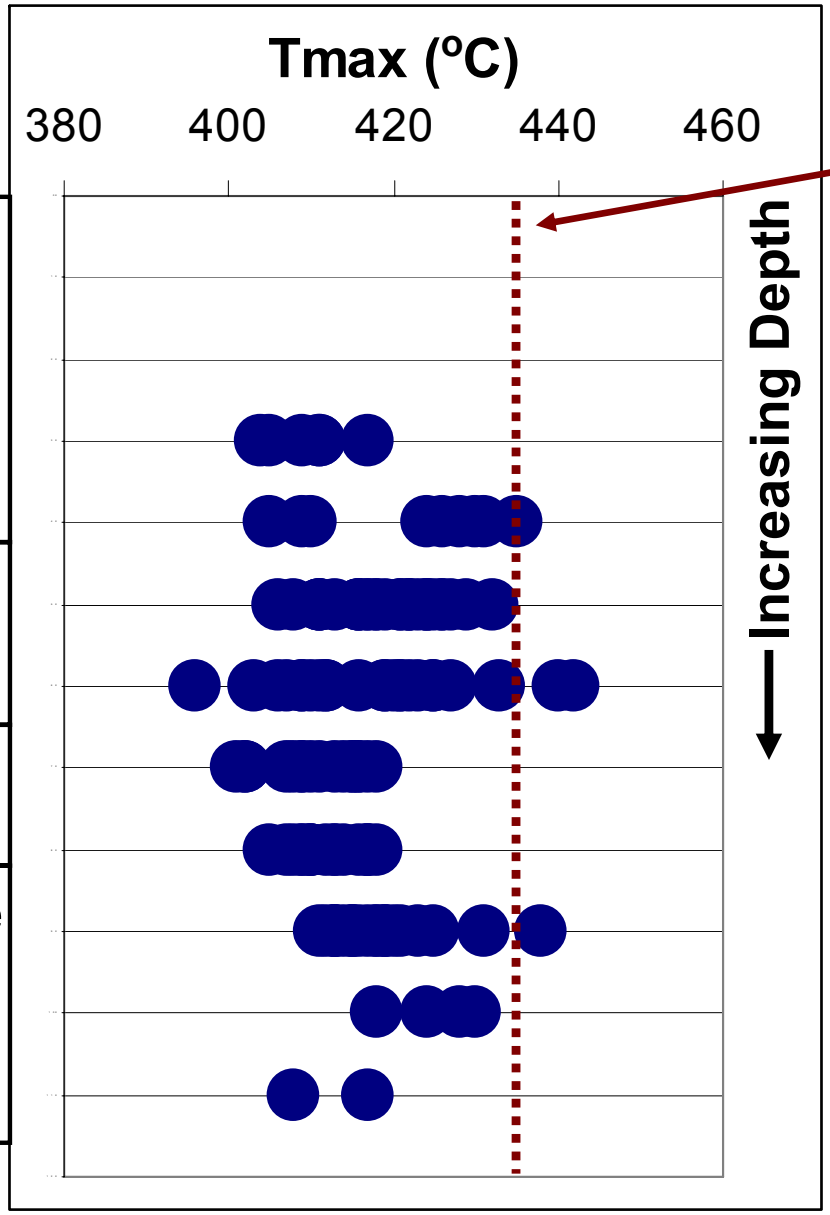
- 2 gas wells
- 3 domestic water wells

Rock Geochemistry & Mineralogy

- Results received & compiled:
  - Rock-Eval 6®:
    - A total of 355 samples analysed & compiled to date, includes:
      - 87 samples from new outcrop and core samples collected from this study and select samples from Nicolas (2009; GP2009-1)
      - Archive data from GSC Open File 4952
  - XRD
    - 47 samples analysed to date (Pembina Mb, Boyne Mb, Morden Mb, Assiniboine Mb)
- Results pending
  - bulk geochemistry

Rock-Eval 6® Results: T_{max}

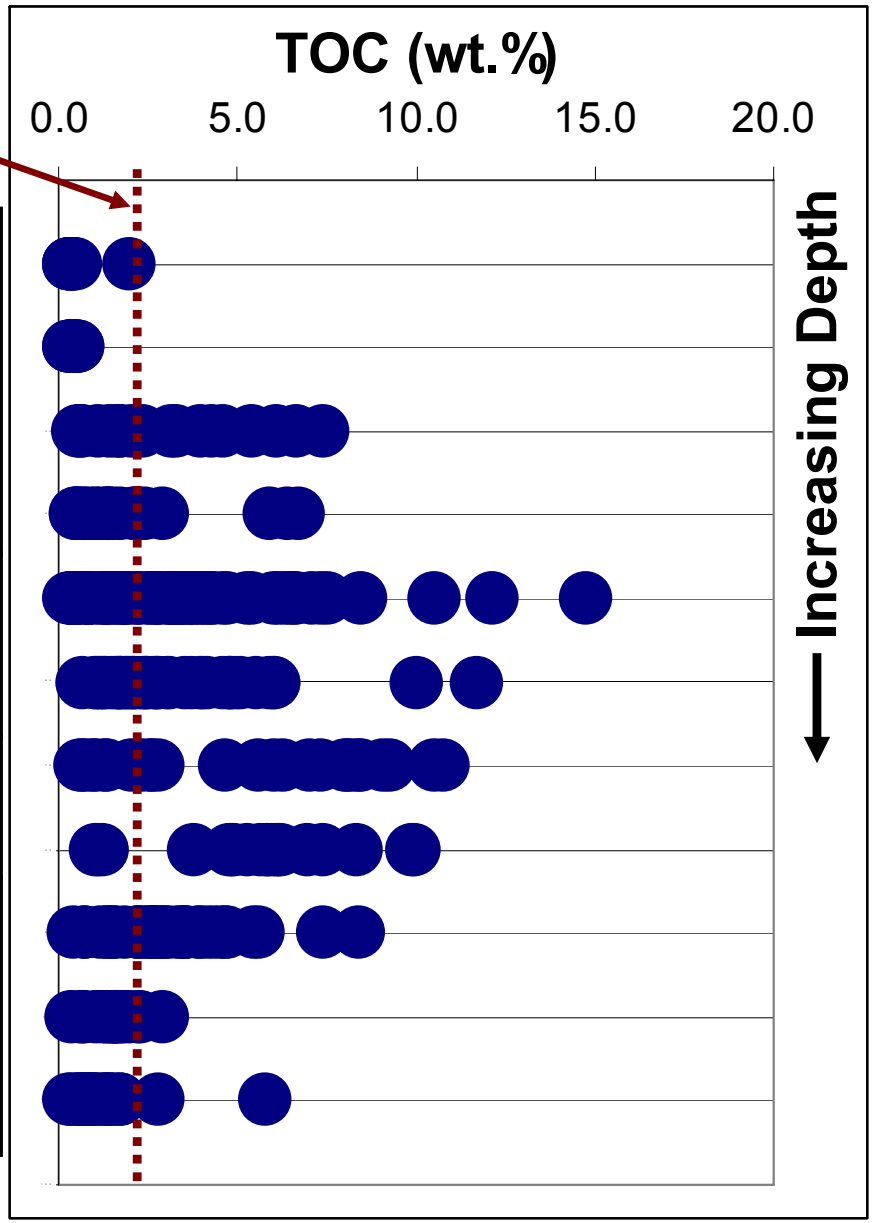
Pierre Shale	Odanah
	Millwood
	Pembina
	Gammon
Carlile Fm	Boyne
	Morden
Favel Fm	Assiniboine
	Keld
Ashville Fm	Belle Fourche
	Westgate
	Skull Creek



Rock-Eval 6® Results: TOC

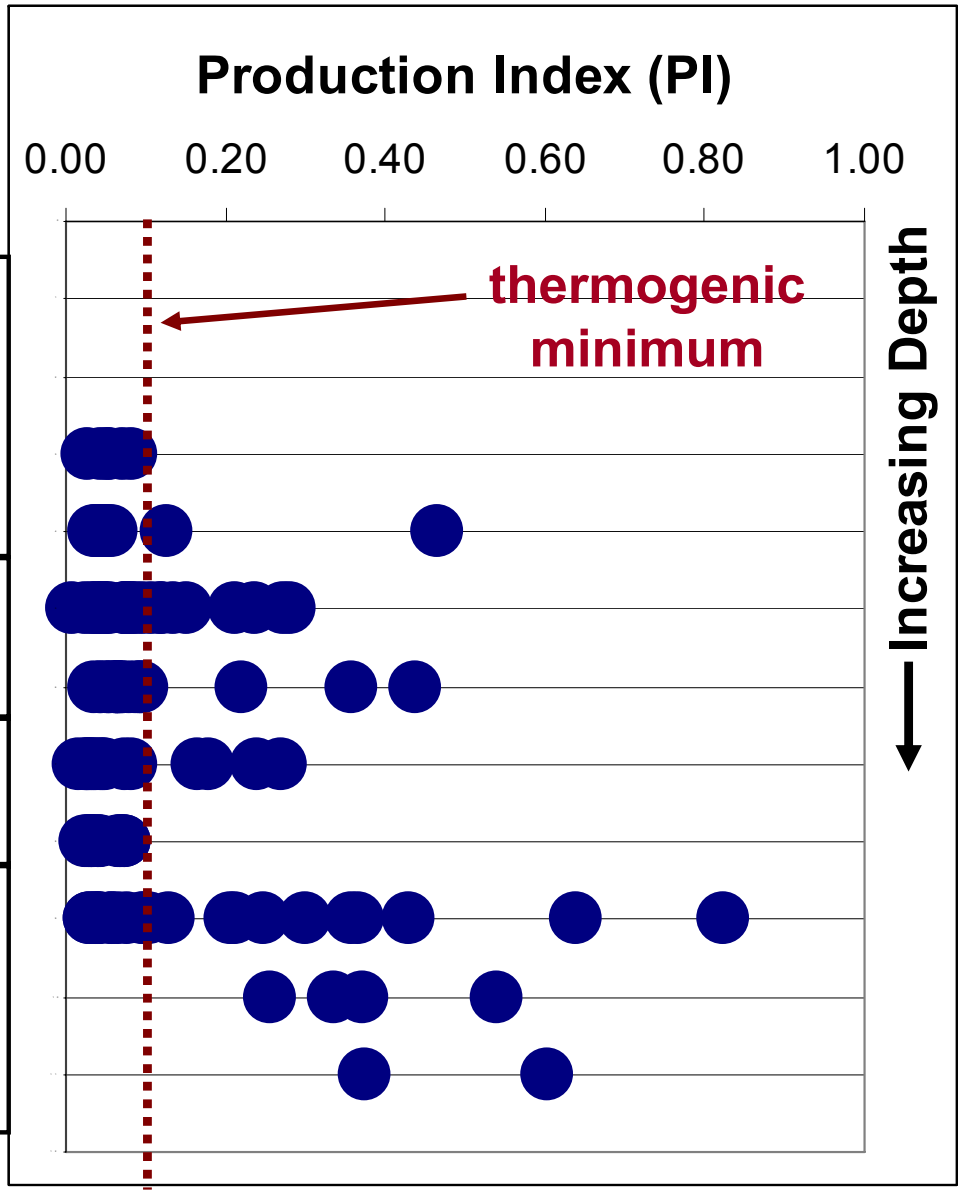
good source rock
(2 wt.% min.)

Pierre Shale	Odanah
	Millwood
	Pembina
	Gammon
Carlile Fm	Boyne
	Morden
Favel Fm	Assiniboine
	Keld
Ashville Fm	Belle Fourche
	Westgate
	Skull Creek



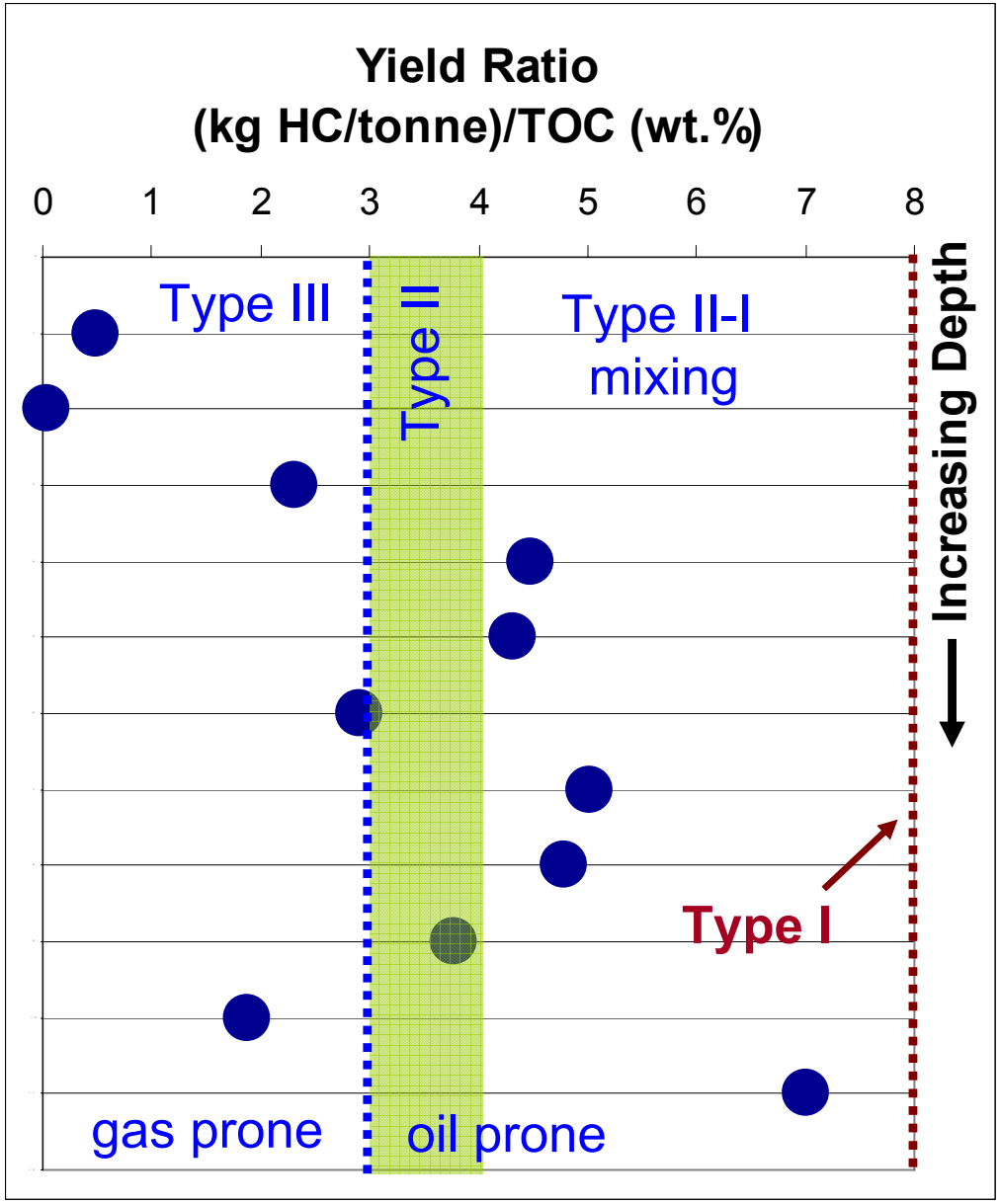
Rock-Eval 6® Results: PI {S1/(S1+S2)}

Pierre Shale	Odanah Millwood Pembina Gammon
Carlile Fm	Boyne Morden
Favel Fm	Assiniboine Keld
Ashville Fm	Belle Fourche Westgate Skull Creek

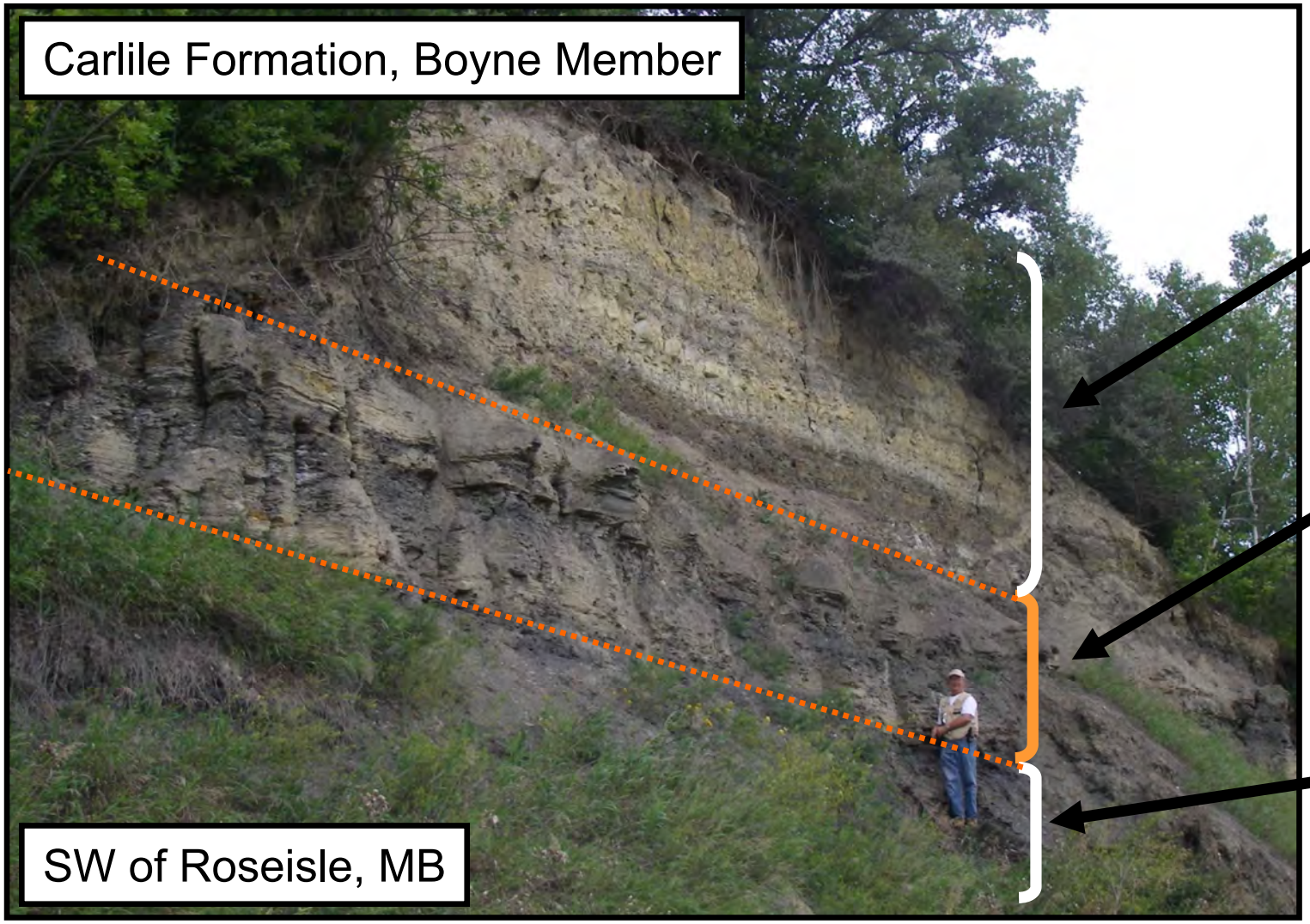


Rock-Eval 6® Results: Yield Ratio

Pierre Shale	Odanah Millwood Pembina Gammon
Carlile Fm	Boyne Morden
Favel Fm	Assiniboine Keld
Ashville Fm	Belle Fourche Westgate Skull Creek



Geochemistry Highlights



brown shale
TOC = 6.51 wt.%

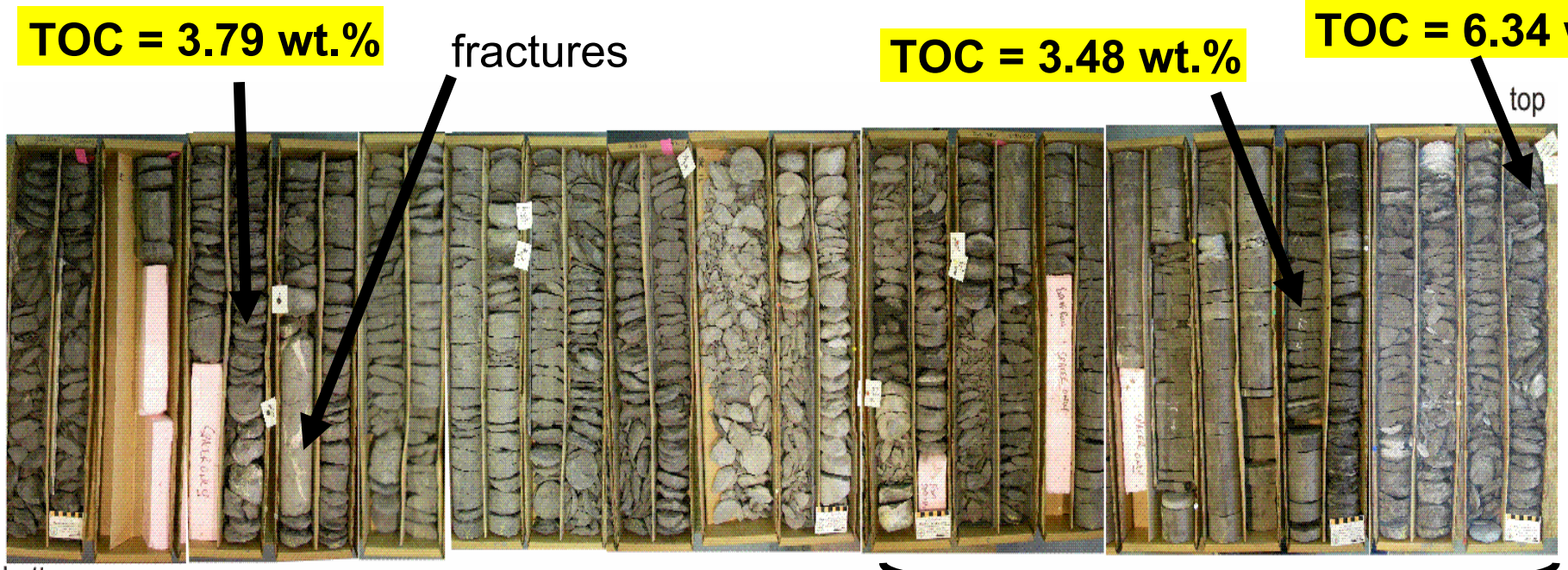
organic shaly siltstone and sandstone
TOC = 10.55 wt.%

black organic shale
TOC = 3.11 wt.%

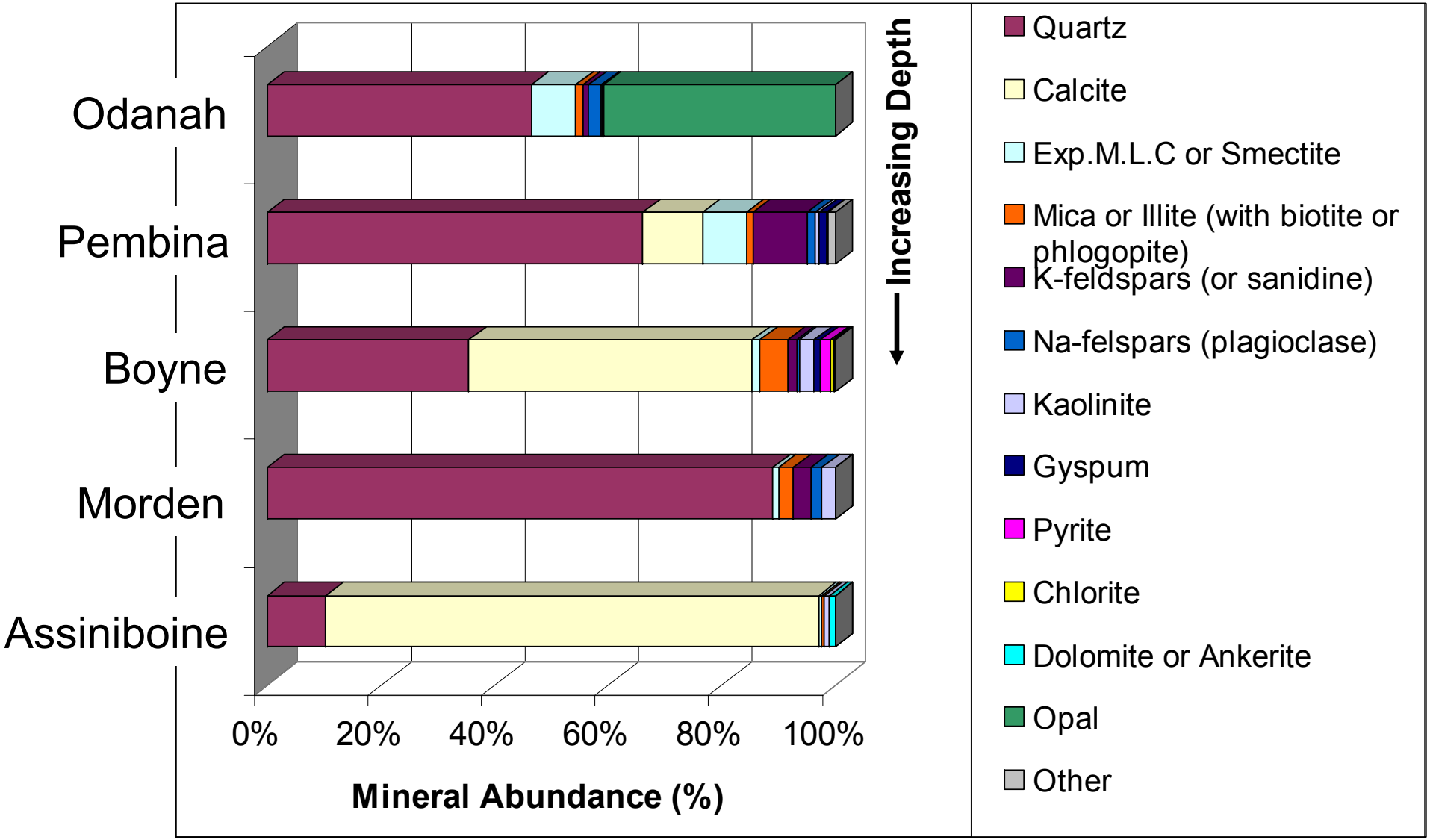
Core Highlights

ϕ

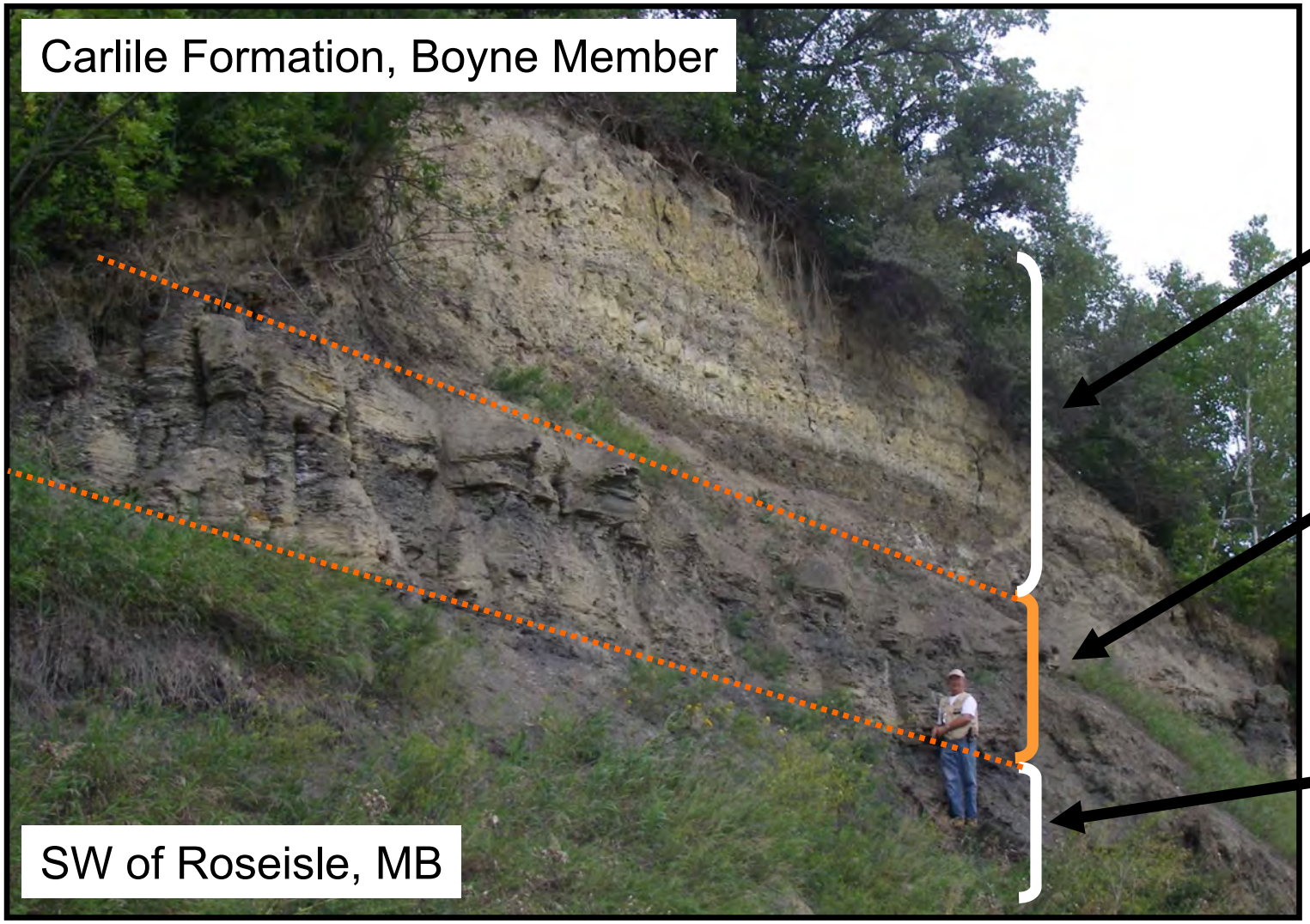
8-29-4-29W1
Carlile Formation, Boyne Member
Core interval: 420.0 – 463.95 m



XRD Results: Mineral Abundance



XRD Results: Quartz Content



brown shale
Qtz = 45%

organic shaly siltstone and sandstone
Qtz = 56%

black organic shale
Qtz = 89%

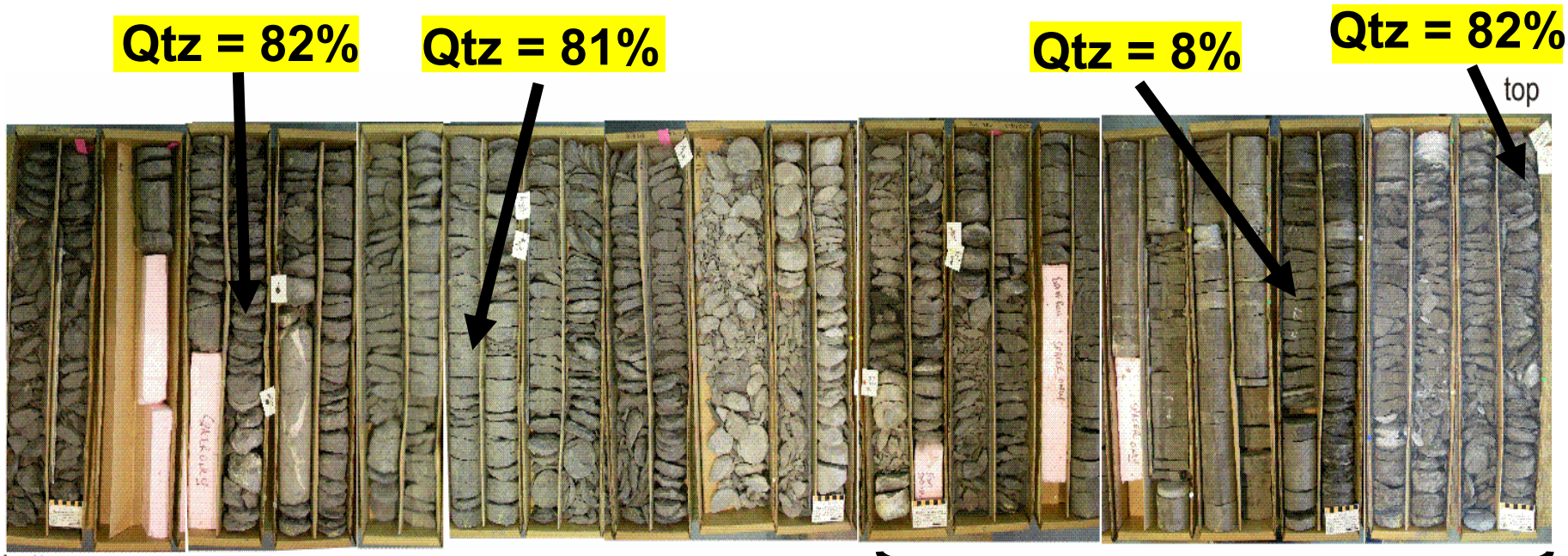
XRD Results: Quartz Content

ϕ

8-29-4-29W1

Carlile Formation, Boyne Member

Core interval: 420.0 – 463.95 m



Water and Gas Geochemistry

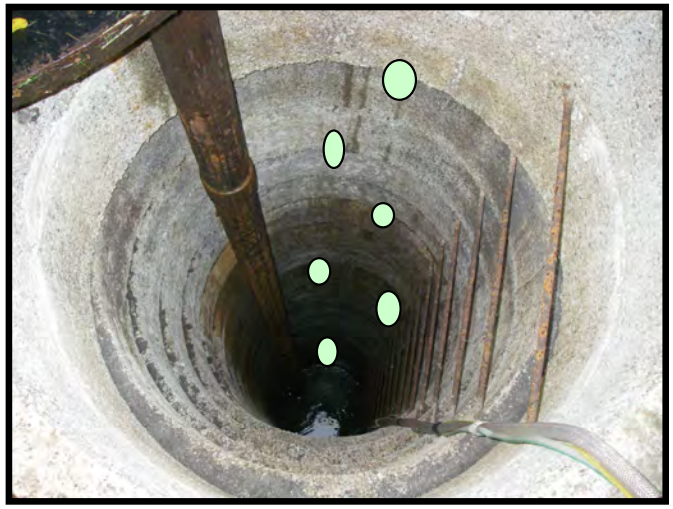
- Results received:
  - Dissolved gas compositions
  - Free gas compositions

- Results pending:
  - Water chemistry
  - Stable isotopes

Water and Gas Geochemistry

- Notre Dame de Lourdes, MB (1930 water/gas well)

methane (CH_4)	81.87 %
nitrogen (N_2)	16.79 %
oxygen (O_2)	0.460 %
carbon dioxide (CO_2)	0.37 %
ethane (C_2H_6)	0.219 %
argon (Ar)	0.151 %
helium (He)	0.1350 %
propane (C_3H_8)	0.0038 %



Water and Gas Geochemistry

- Manitou, MB
  (1933 gas well)

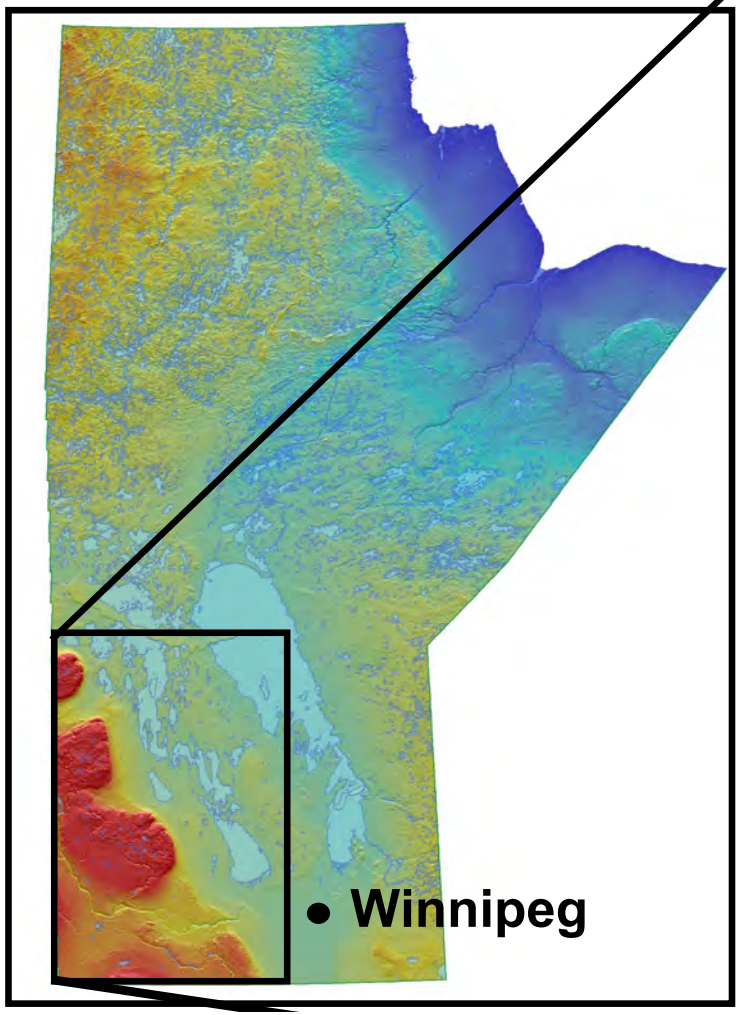
methane (CH_4)	89.69 %
nitrogen (N_2)	9.34 %
oxygen (O_2)	0.375 %
ethane (C_2H_6)	0.260 %
carbon dioxide (CO_2)	0.180 %
argon (Ar)	0.0896 %
helium (He)	0.0379 %
propane (C_3H_8)	0.0171 %
iso-butane (C_4H_{10})	0.0063 %

Water and Gas Geochemistry

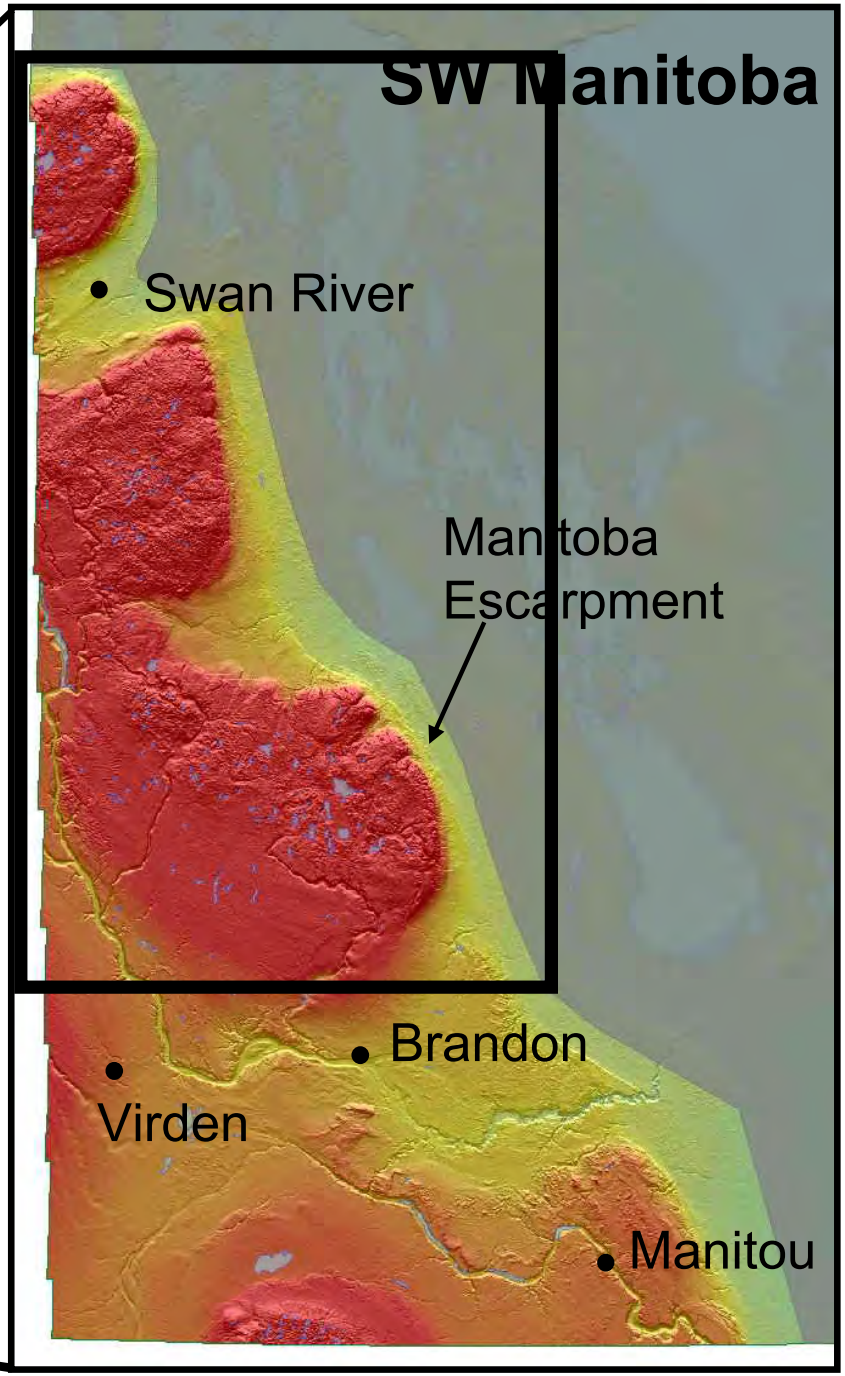
- Manitou, MB (domestic water well)

methane (CH_4)	84.80 %
nitrogen (N_2)	13.34 %
carbon dioxide (CO_2)	1.40 %
argon (Ar)	0.249 %
oxygen (O_2)	0.192 %
helium (He)	0.0118 %
ethane (C_2H_6)	0.0028 %

2009 Field Work



DEM of Manitoba, Canada



Conclusions

- Manitoba has a vast shale gas resource that has not been adaquately explored with modern technology.
- Manitoba is not “just shale”, siltstone and sandstones do occur in the east.
- Manitoba does have the right geological conditions for shale gas.
  - Is it economic?

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Conclusions

- Best Cretaceous shale gas targets:
  - Carlile Formation
  - Favel Formation
  - Ashville Formation, Belle Fourche Membre
- Geochemistry results support that this is an unconventional biogenic shallow gas play.
  - still need stable isotope confirmation
- Likely a combination of early-generation and late-generation gas.

Want to know more?

- Manitoba exhibit booth
- Report of Activities 2008
  - Nicolas (2008): GS-16
  - Bamburak (2008): GS-17
- TGI II Manitoba Mesozoic Report
  - Nicolas (2009): GP2009-1
- Order online or download for free at:

www.manitoba.ca/minerals

Acknowledgement

- **Geological Survey of Canada – Calgary**

  Martin Fowler

  Kirk Osadetz

  Steve Grasby

- **Manitoba Water Stewardship, Water Resources Branch**

  Bob Betcher

  Tobin Harrison

Manitoba

The end.