# Assessment of Undiscovered Oil and Gas Resources of the Williston Basin Province of North Dakota, Montana and South Dakota*

**Lawrence Anna[1], Richard M. Pollastro[1], Stephanie B. Gaswirth[1], Paul Lillis[1], Laura N. Roberts[1] and Troy Cook[1]**

Search and Discovery Article #10201 (2009)
Posted August 24, 2009

*Adapted from oral presentation at AAPG Convention, Denver, Colorado, June 7-10, 2009

[1]USGS, Lakewood, CO (mailto:lanna@usgs.gov)

## Abstract

The U.S. Geological Survey (USGS) completed an assessment of the undiscovered oil and gas resources in conventional and continuous accumulations of the Williston Basin Province of North Dakota, eastern Montana, and northwestern South Dakota. The assessment is based on geologic elements and associated processes that define a total petroleum system (TPS), including (1) stratigraphic and structural geology framework; (2) source rock distribution, thickness, organic richness, maturation, petroleum generation, and migration; and (3) reservoir type (conventional or continuous), distribution, and quality. These elements combined with burial history modeling, and petroleum geochemistry and historical exploration and production analyses, were used in estimating the undiscovered, technically recoverable oil and gas resources within the Cambrian to Tertiary strata of the U.S. part of the basin.

The USGS estimated means of 3,844 million barrels of oil (MMBO), 3,705 billion cubic feet of gas (BCFG), and 202 million barrels of natural gas liquids (MMBNGL) for undiscovered continuous and conventional resources in the 10 TPSs and 19 assessment units that were defined in the Williston Basin Province. The assessment indicates that most of the undiscovered oil resource is within the Bakken Formation as a continuous reservoir with a mean of 3,645 MMBO, whereas undiscovered oil from conventional reservoirs has a much lesser mean of 197 MMBO. All of the undiscovered continuous gas resides in the Bakken as associated gas with a mean of 1,848 BCFG, and in Tertiary coalbeds with a mean of 882 BCFG. Most of the undiscovered conventional oil is in the Mississippian Madison Group with a mean of 45 MMBO, and the Ordovician Red River Formation with a mean of 30 MMBO. Oil from other Paleozoic reservoirs is estimated at a mean of 122 MMBO. Undiscovered conventional gas resources from Paleozoic and Tertiary reservoirs are estimated at a mean of 976 BCFG.

# USGS
# Assessment of Undiscovered Oil & Gas Resources of the Williston Basin

## DENVER TEAM

- Rich Pollastro – Bakken
- Stephanie Gaswirth – Madison Group
- Larry Anna – Lower Pz, Tyler, Cretaceous, CBM
- Troy Cook – Petroleum Engineering
- Paul Lillis, Mike Lewan – Geochemistry
- Laura Roberts – Burial History Modeling

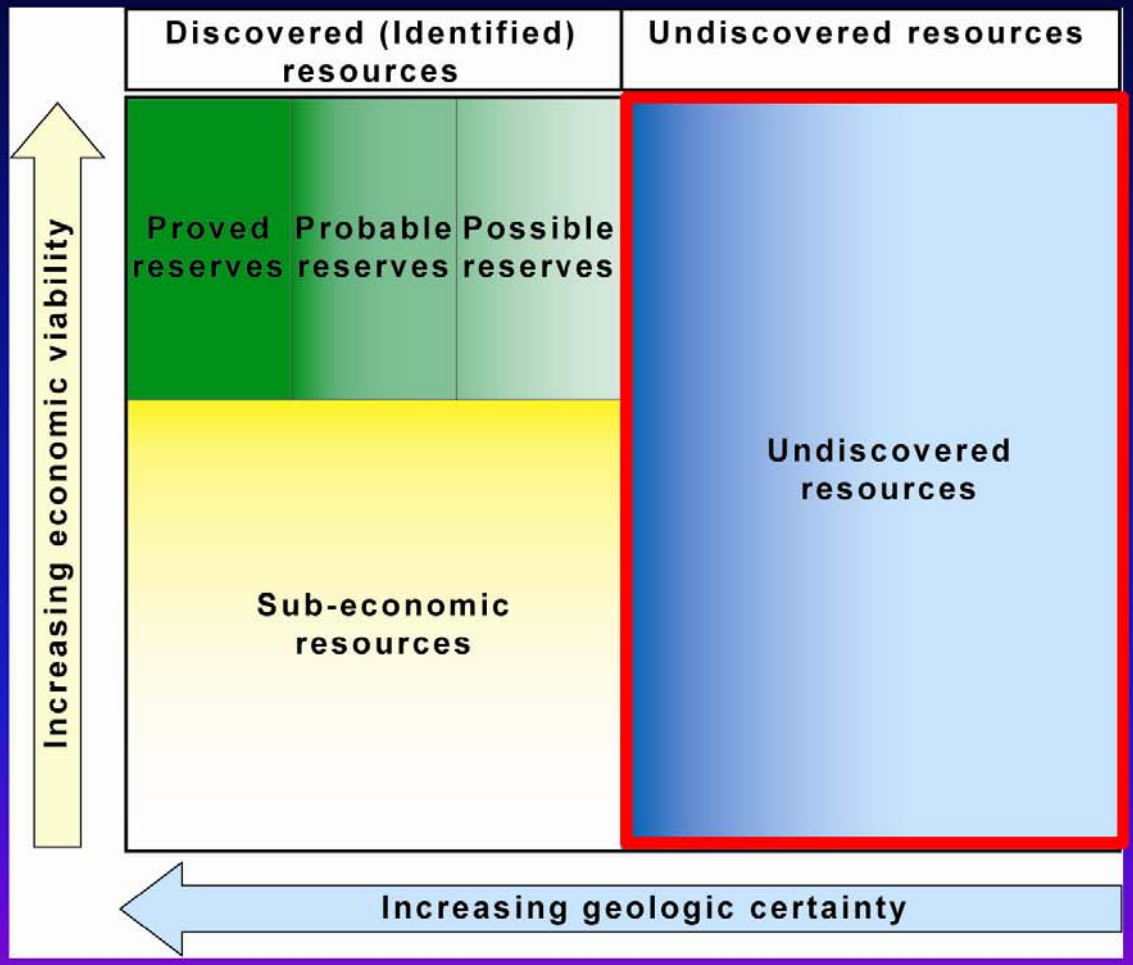
://energy.cr.usgs.gov/oilgas/noga/

USGS

AAPG Convention 2009, Denver Colo

Notes by Presenter: Today's talk is presented to show our assessment results of the Williston Basin. Listed here are the individuals who worked on the project. There are other publications on our web site listed here.

# Resources vs. Reserves




**USGS produces estimates of undiscovered, technically recoverable resources.**

USGS

Notes by Presenter: We make an important distinction between resources and reserves.

# Statistics

- **Cumulative Production (2008)**
  - **> 2.70 BBO,  2.80 TCFG**
  - **> 3.20 BBOE**

- **Undiscovered technically recoverable resource for U.S. (mean)**
  - **- Include Bakken:  3,844 MMBO  3.70 TCFG**
  - **- Without Bakken:  199 MMBO  1.86 TCFG**

# Williston Basin Assessment

- **Approach is geology based**
  - **Develop tectonic and structural framework**
  - **Characterize reservoirs, seals, & strat traps based on sedimentation models**
  - **Characterize source rocks: geochem, burial history, and migration**
- **Analyze production history (Nehring data)**
  - **Numerous plots of production history**
  - **Calculate field growth from known production**

# Williston Basin Assessment

- **Determine Total Petroleum Systems (TPS)**
- **Determine Assessment Units (plays)**

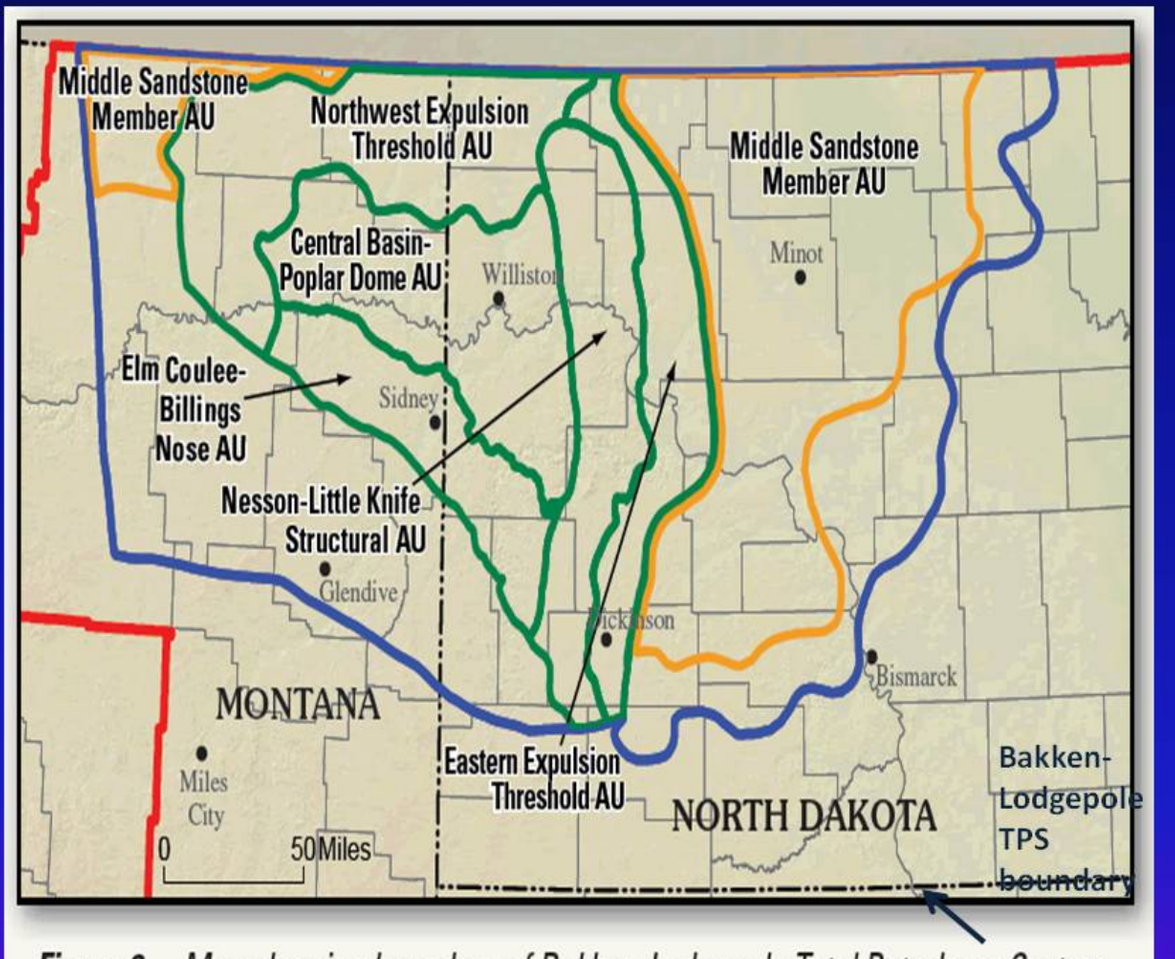
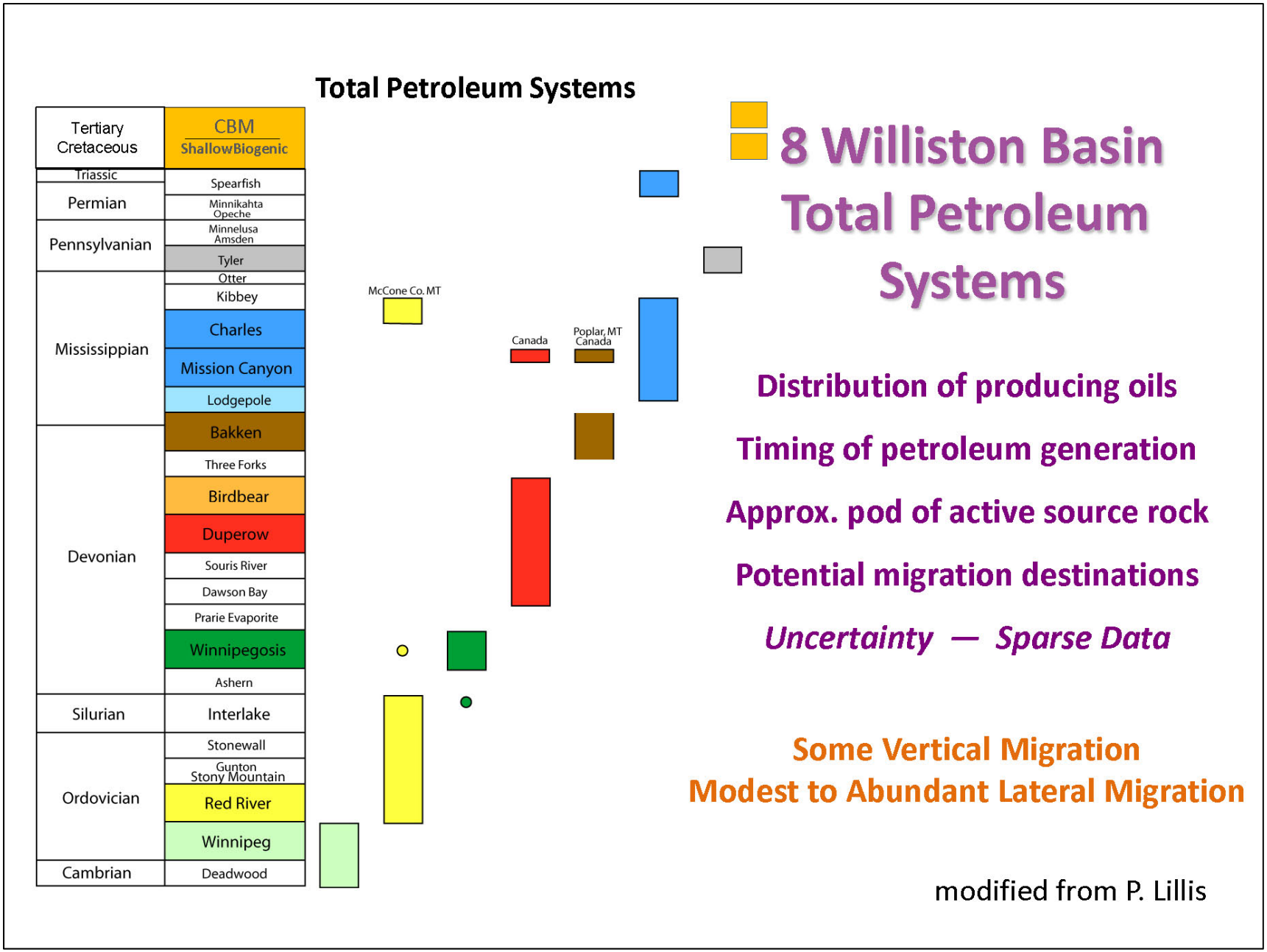



***Figure 2.*** *Map showing boundary of Bakken-Lodgepole Total Petroleum System (TPS) (in blue), five continuous assessment units (AU) (in green), and one conventional AU (in orange) defined for the assessment of undiscovered oil resources in the Upper Devonian–Lower Mississippian Bakken Formation in the U.S. portion of the TPS. The outermost green line defines the area of oil generation for the upper shale member of the formation.*

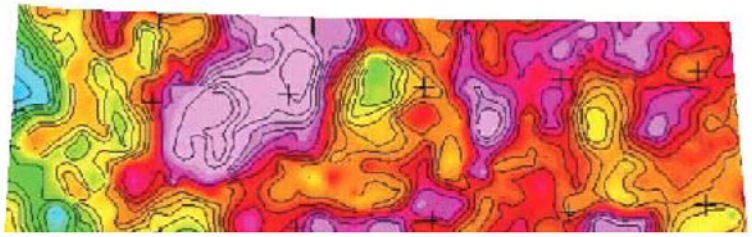
Notes by Presenter: Backbone of the assessment is the TPS and AU..... AU similar reservoir, production characteristics within TPS.

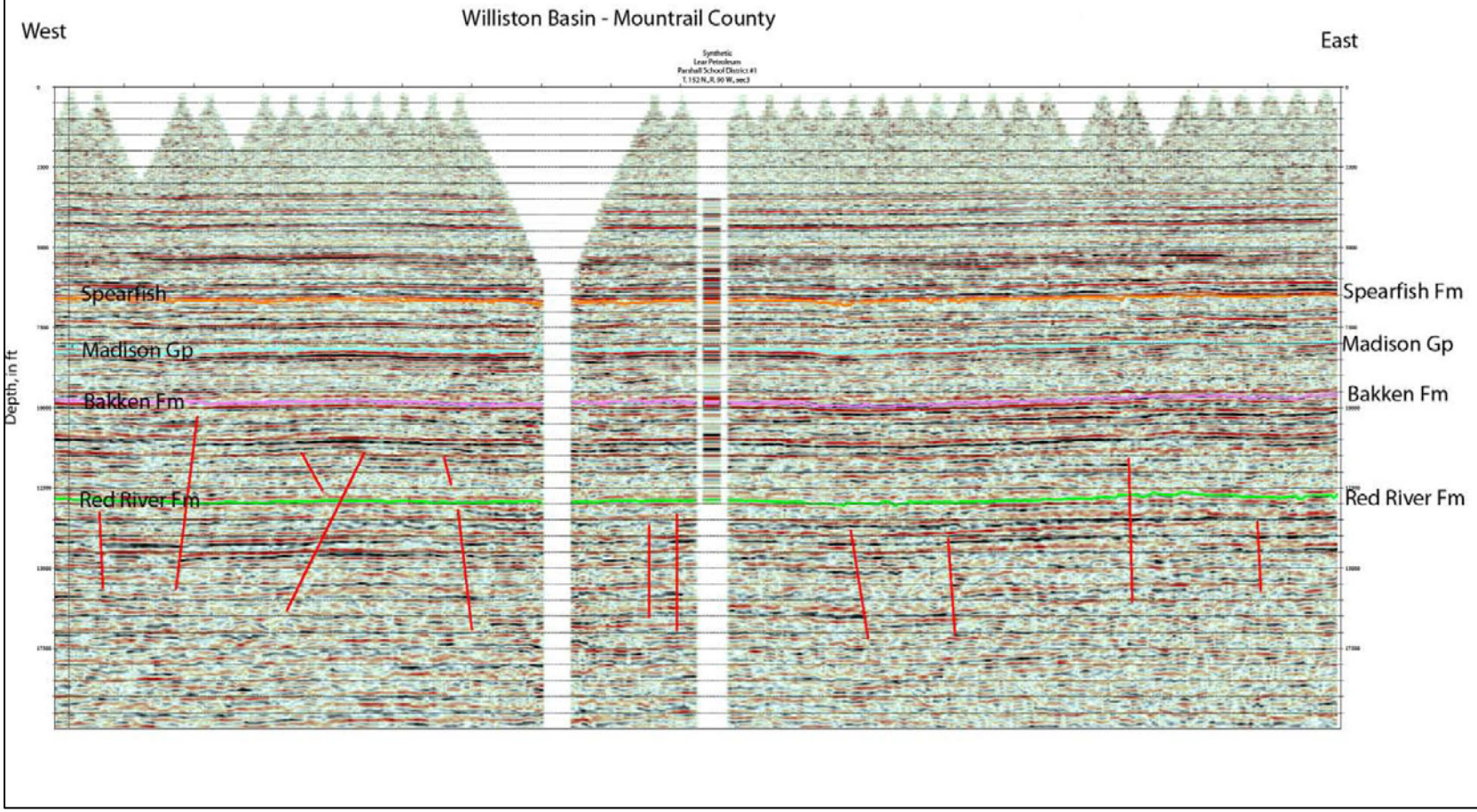



Notes by Presenter: We defined 8 TPS listed here in different colors matched to the Stratigraphic column which depicts the source rock interval. You can see that TPS some vertical migration, but the Winn, Bakken and Tyler have little vertical migration, where as the RR, Winnosis … although there is uncertainty associated with the boundaries because of sparse data.

# Structural Framework

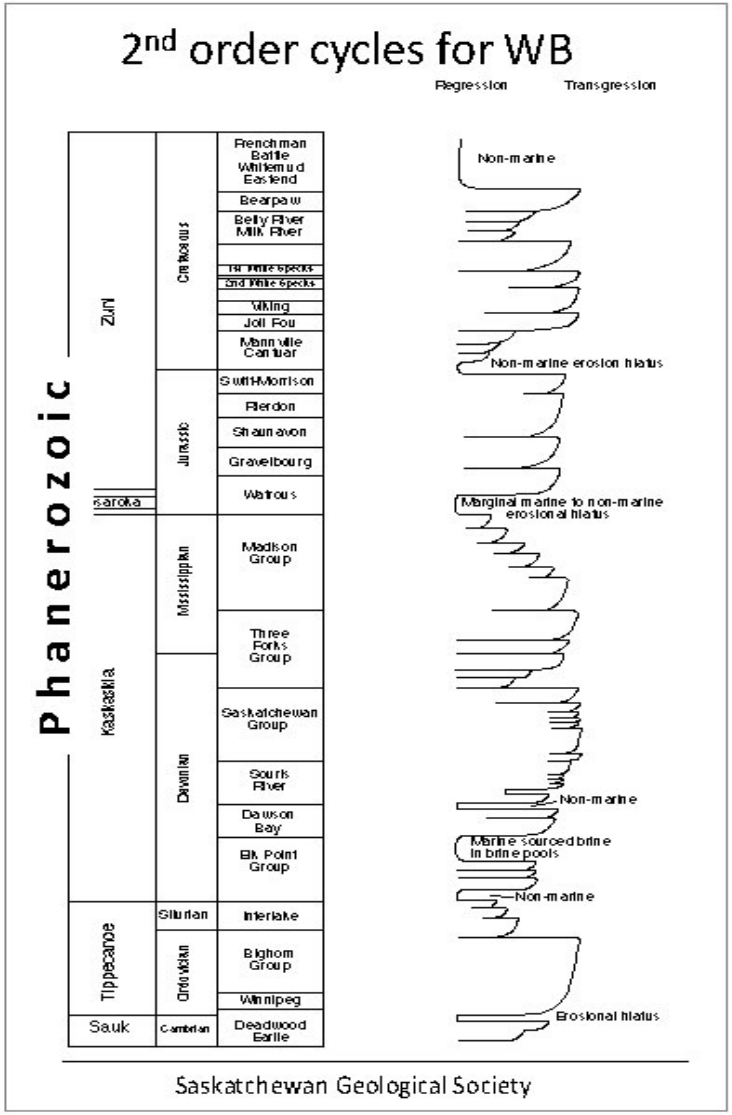
Canada






Notes by Presenter: We think that the ne, nw are Precambrian rooted as in Trans H. recurrent movement influence on sed patterns. Part of our approach was to determine probablility of how many bumps are not drilled or under drilled.

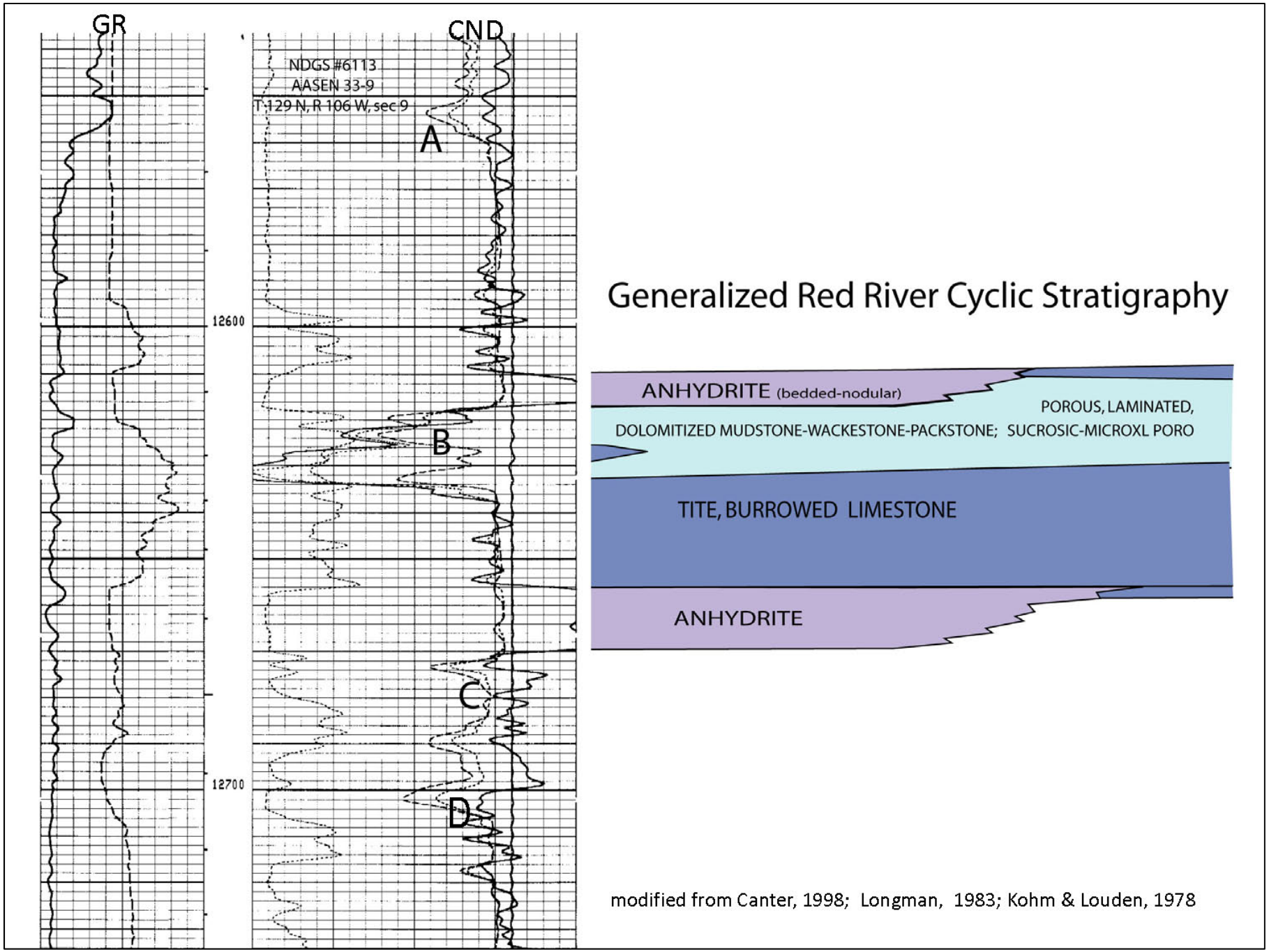
## Develop Carbonate Stratigraphic Model — Reservoir Characteristics



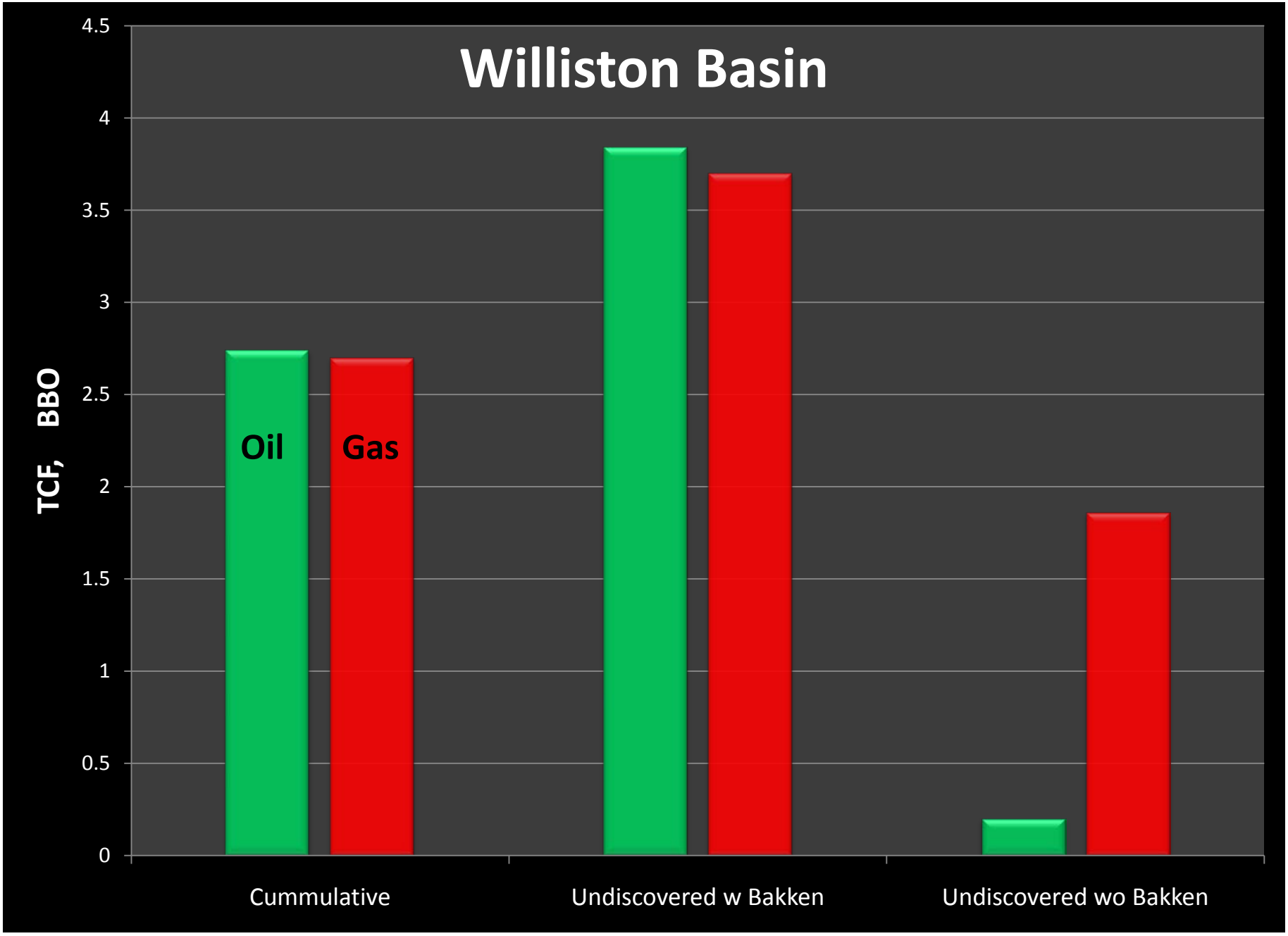

**Carbonate cycles create successions that are self-sufficient**

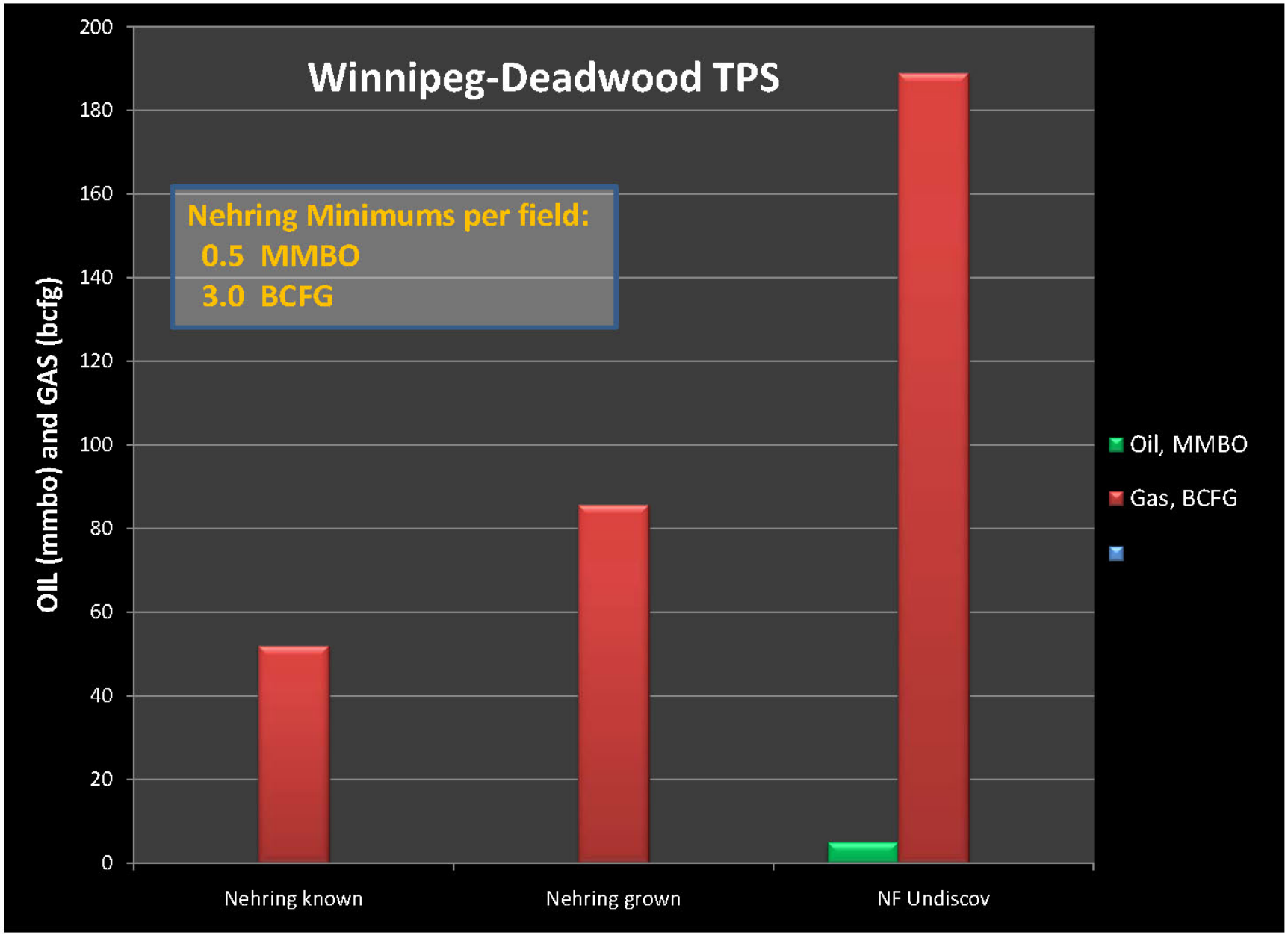
- ✓Seal
- ✓Reservoir
- ✓Source

Notes by Presenter: Our Stratigraphic MODEL is based on cyclic sedimentation.... cycles occur over and over. sub, inter, supra tidal enviorn; source: zones of high Organics.

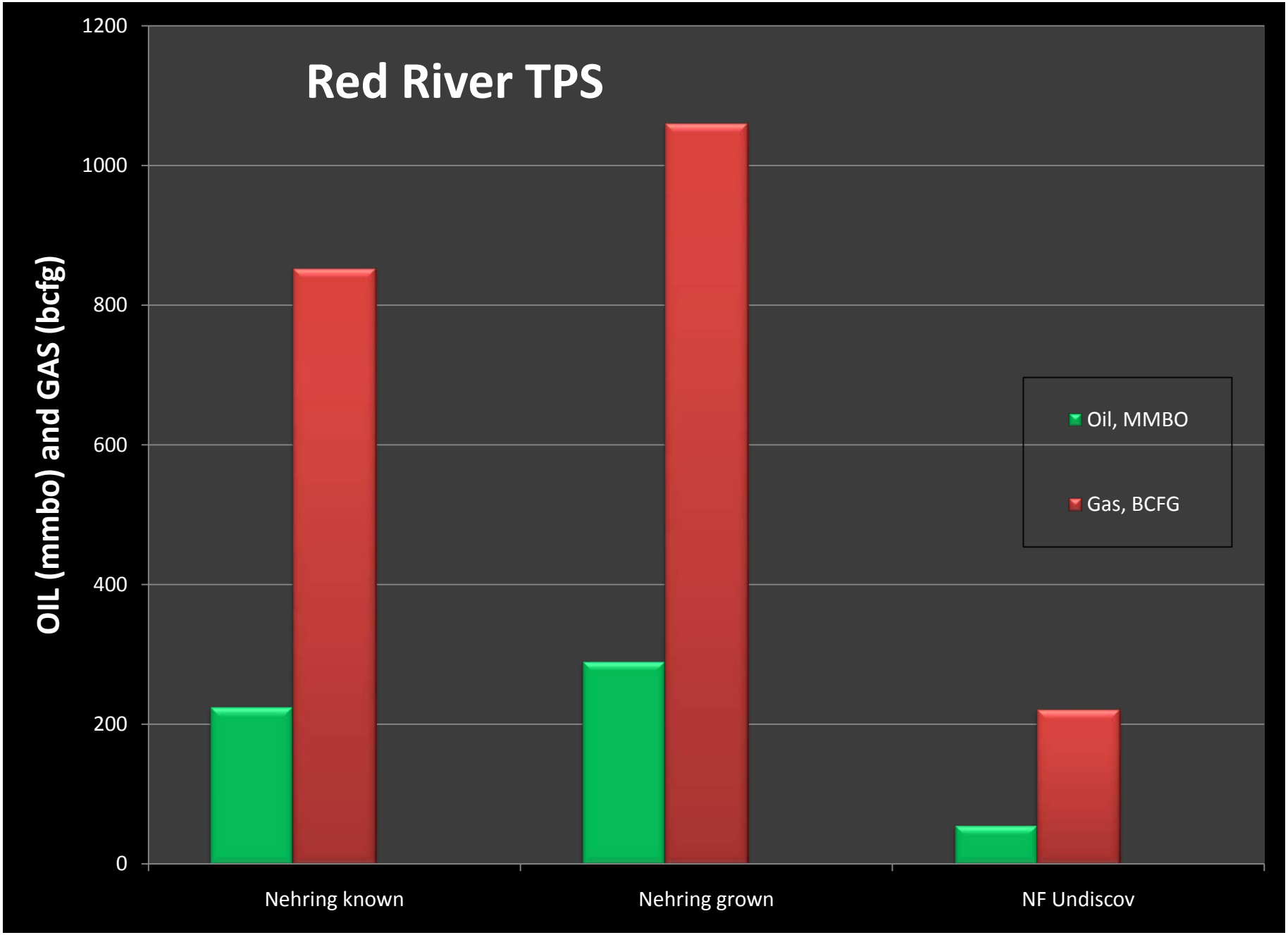


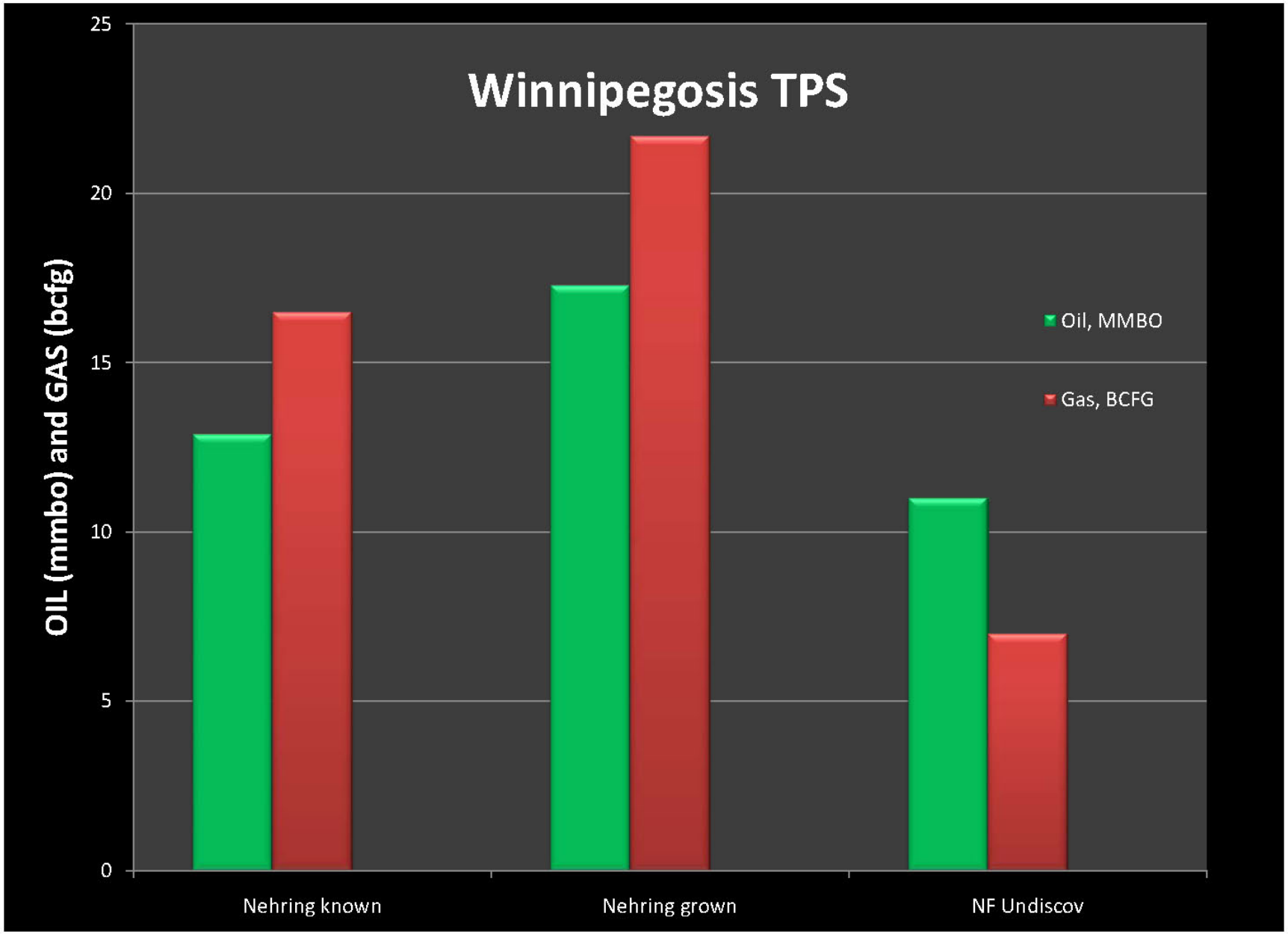

Notes by Presenter: Title burrowed limestone may have organic rich algal layers.


Williston Basin
TCF, BBO
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Oil
Gas
Cummulative
Undiscovered w Bakken
Undiscovered wo Bakken

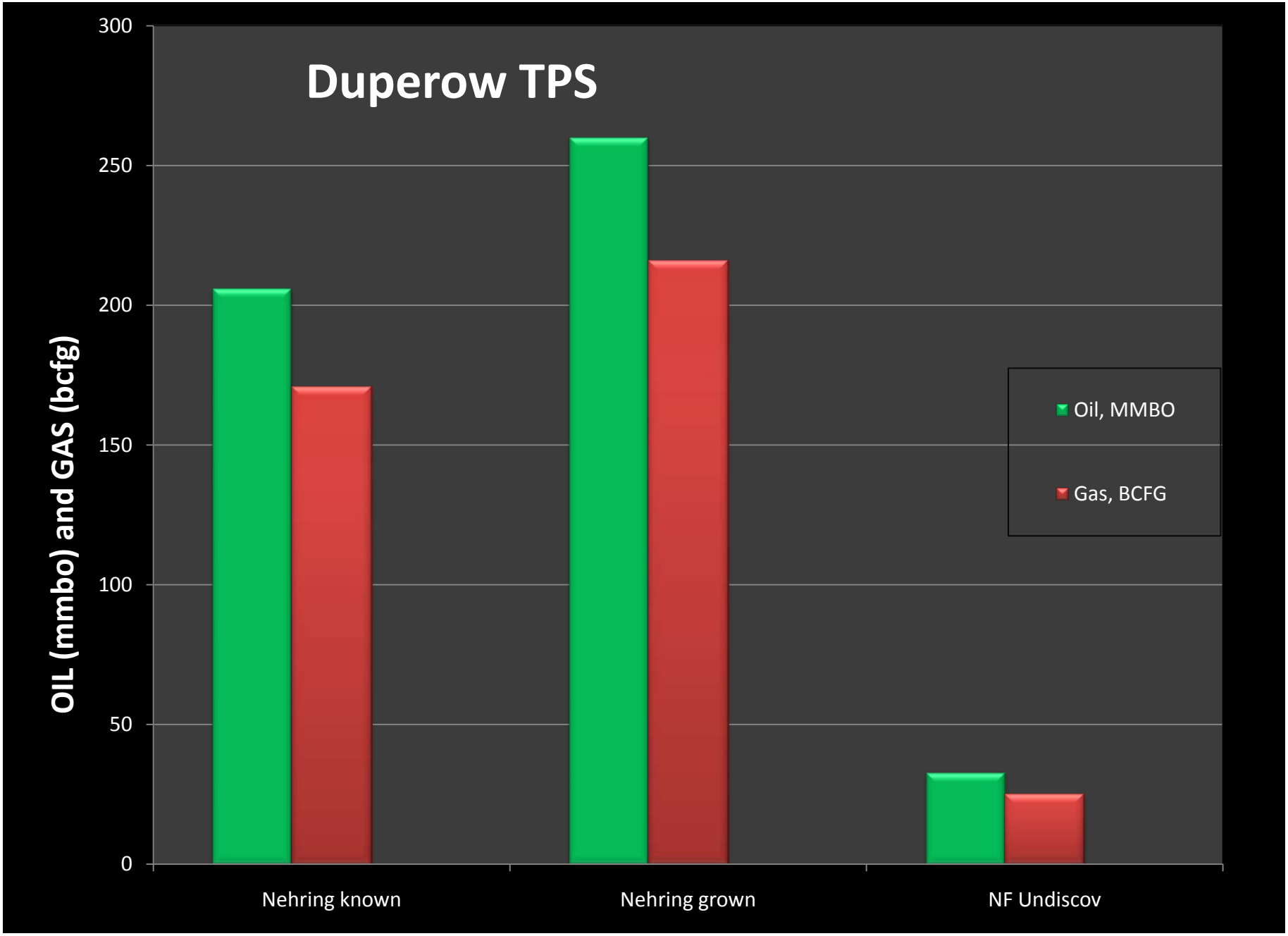


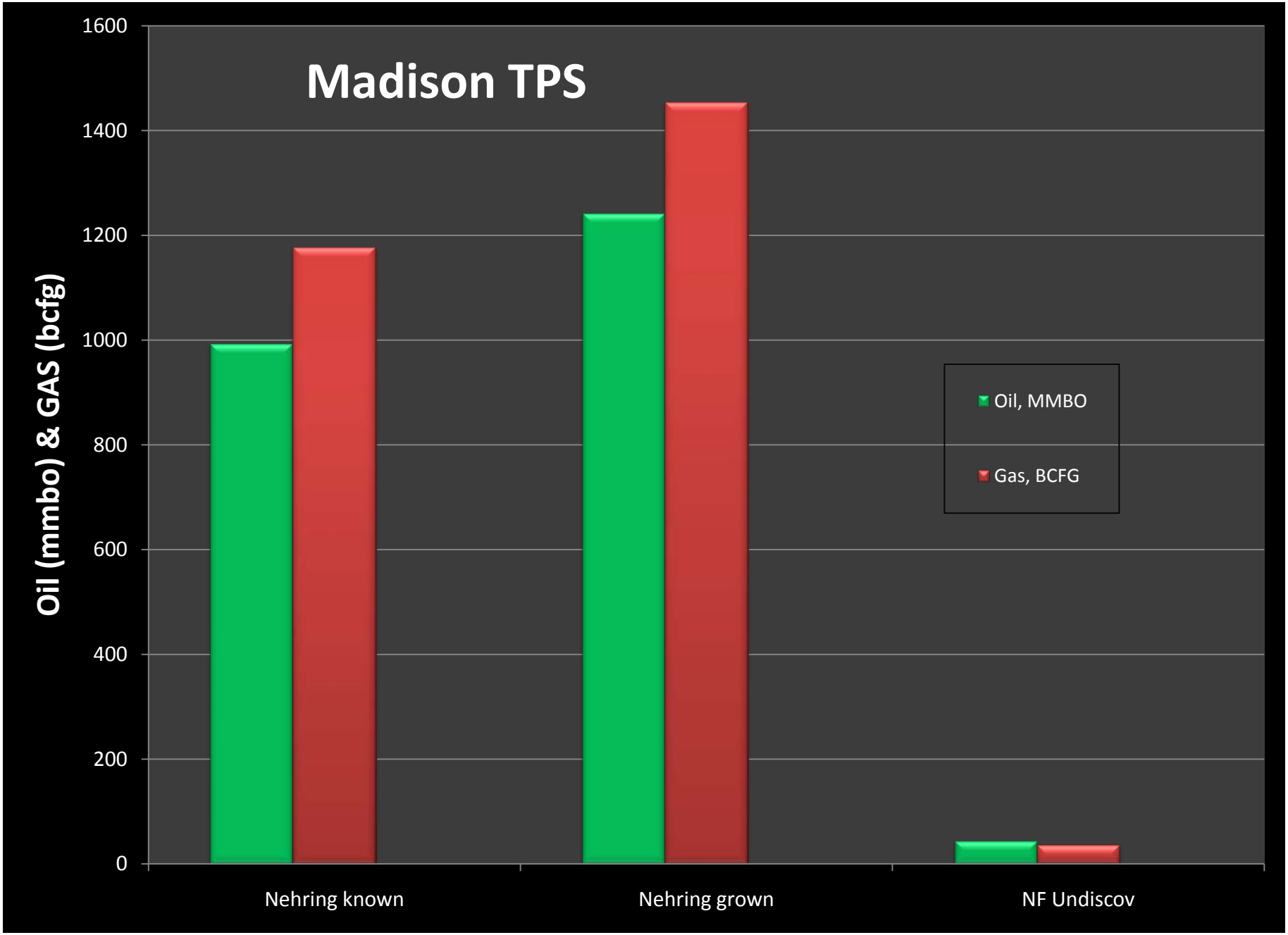

Notes by Presenter: Winnipeg Shale Gas play.

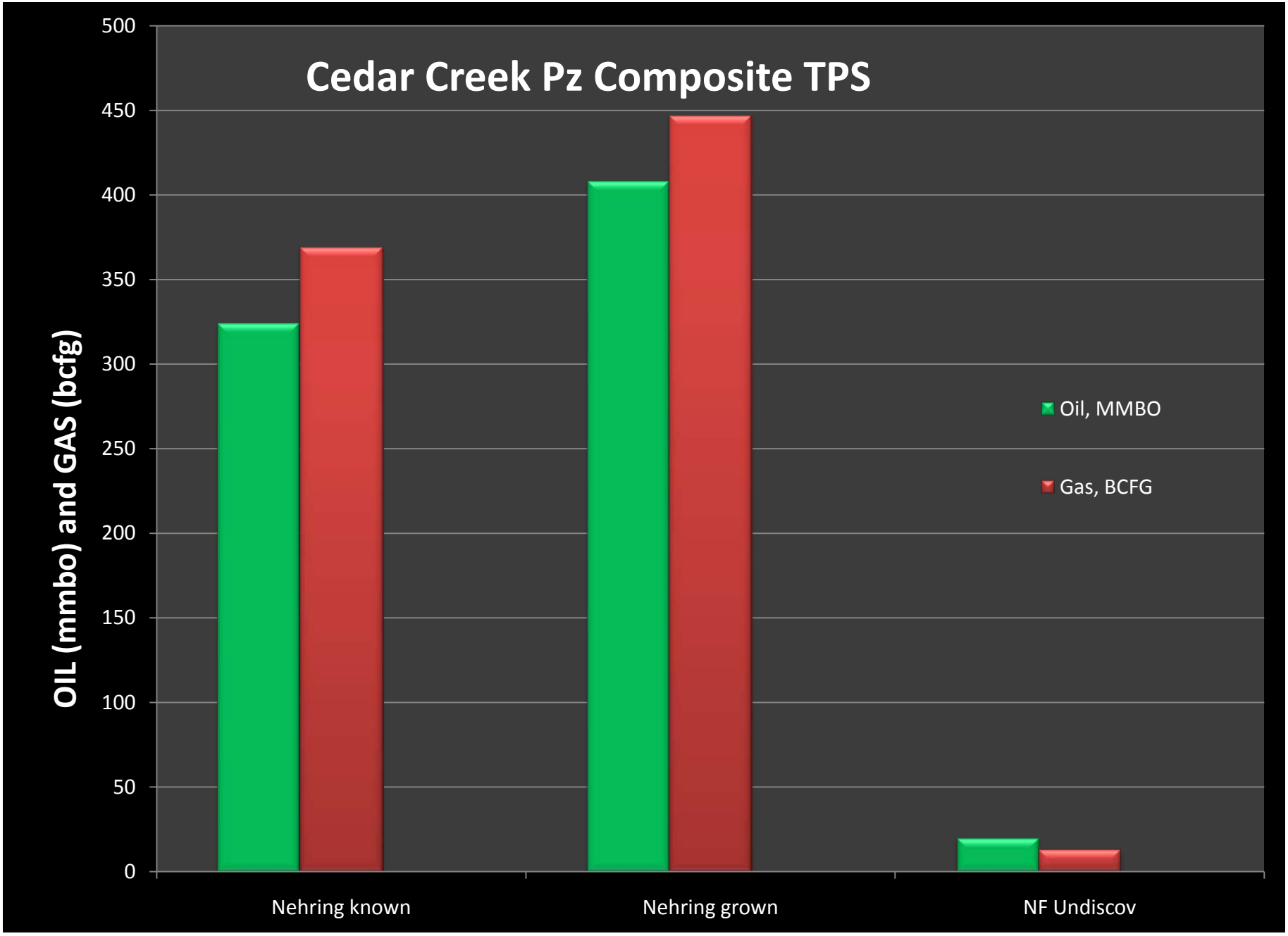

Red River TPS
OIL (mmbo) and GAS (bcfg)
1200
1000
800
600
400
200
0
Nehring known
Nehring grown
NF Undiscov
Oil, MMBO
Gas, BCFG

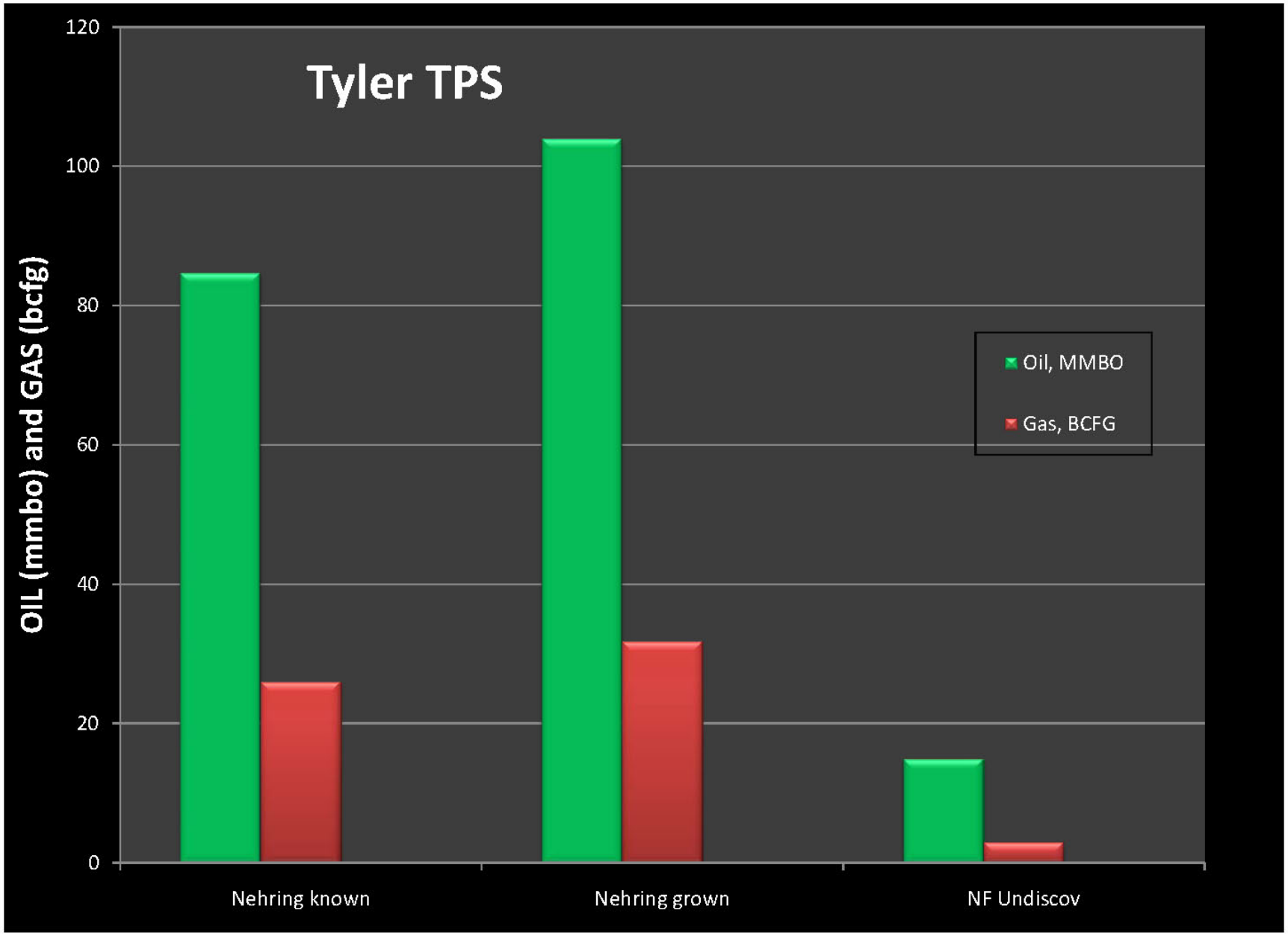



Notes by Presenter: Pinnical reefs.

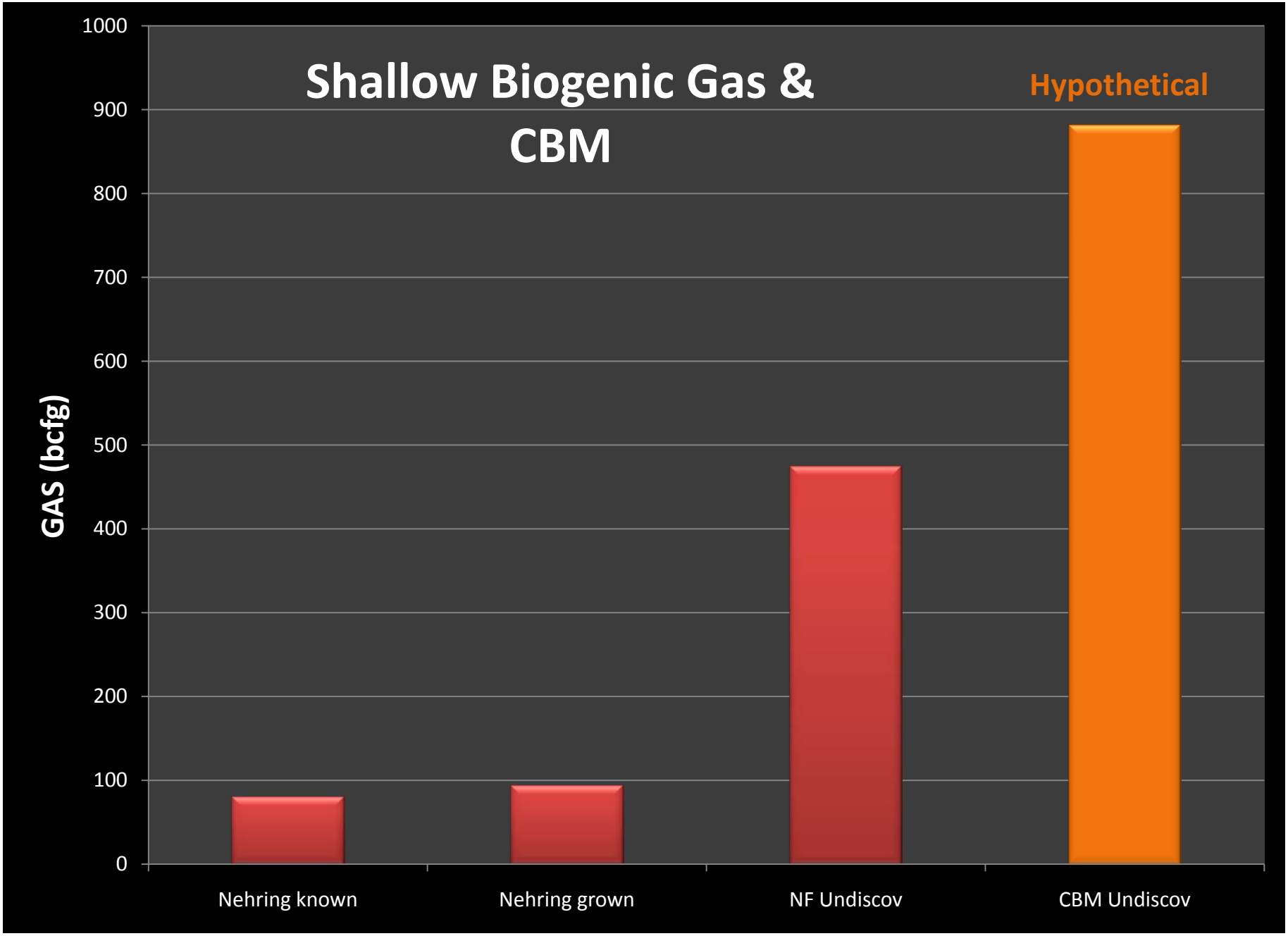

Duperow TPS
OIL (mmbo) and GAS (bcfg)
300
250
200
150
100
50
0
Nehring known
Nehring grown
NF Undiscov
Oil, MMBO
Gas, BCFG

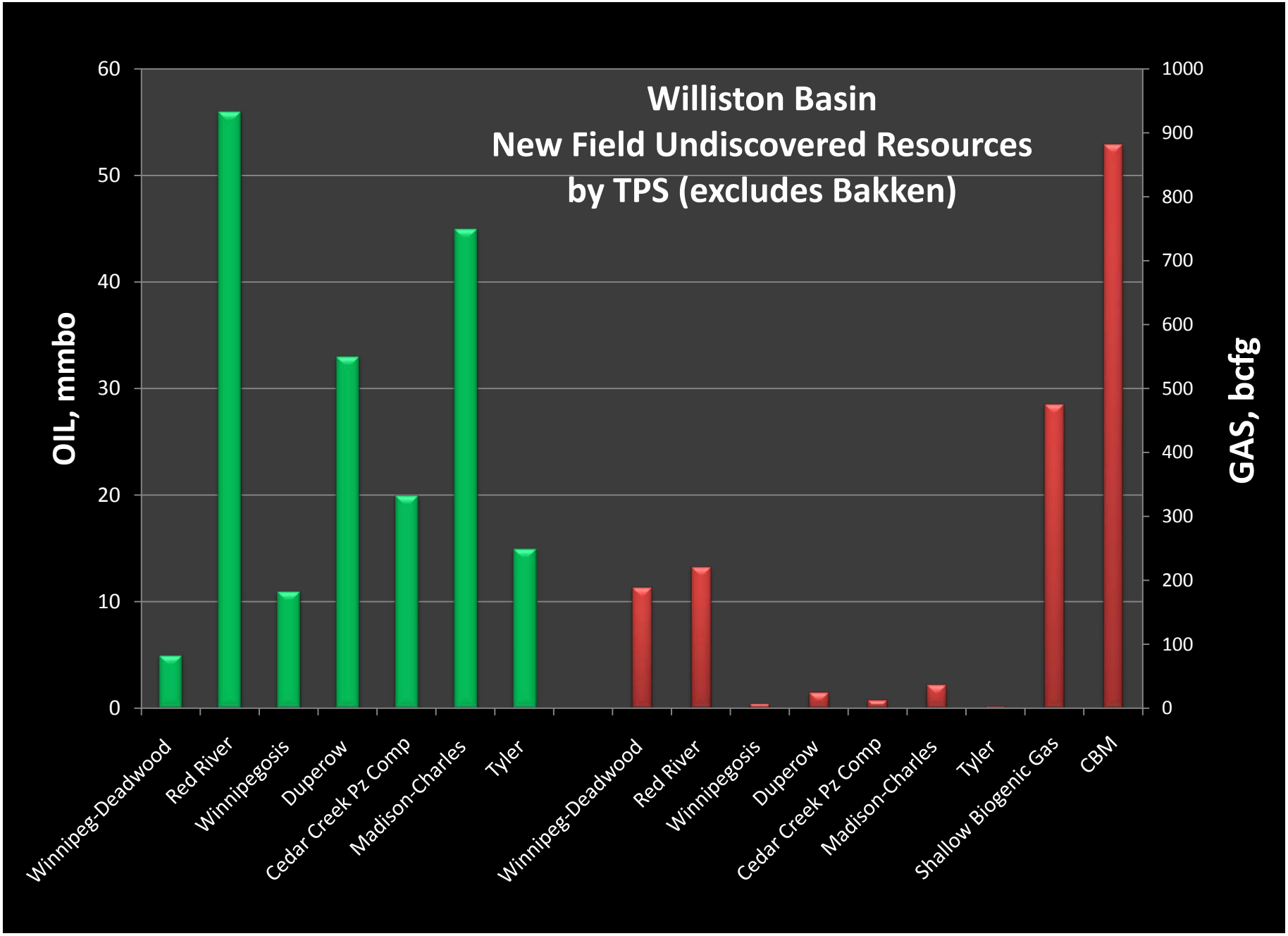

Madison TPS
Oil (mmbo) & GAS (bcfg)
1600
1400
1200
1000
800
600
400
200
0
Nehring known
Nehring grown
NF Undiscov
Oil, MMBO
Gas, BCFG

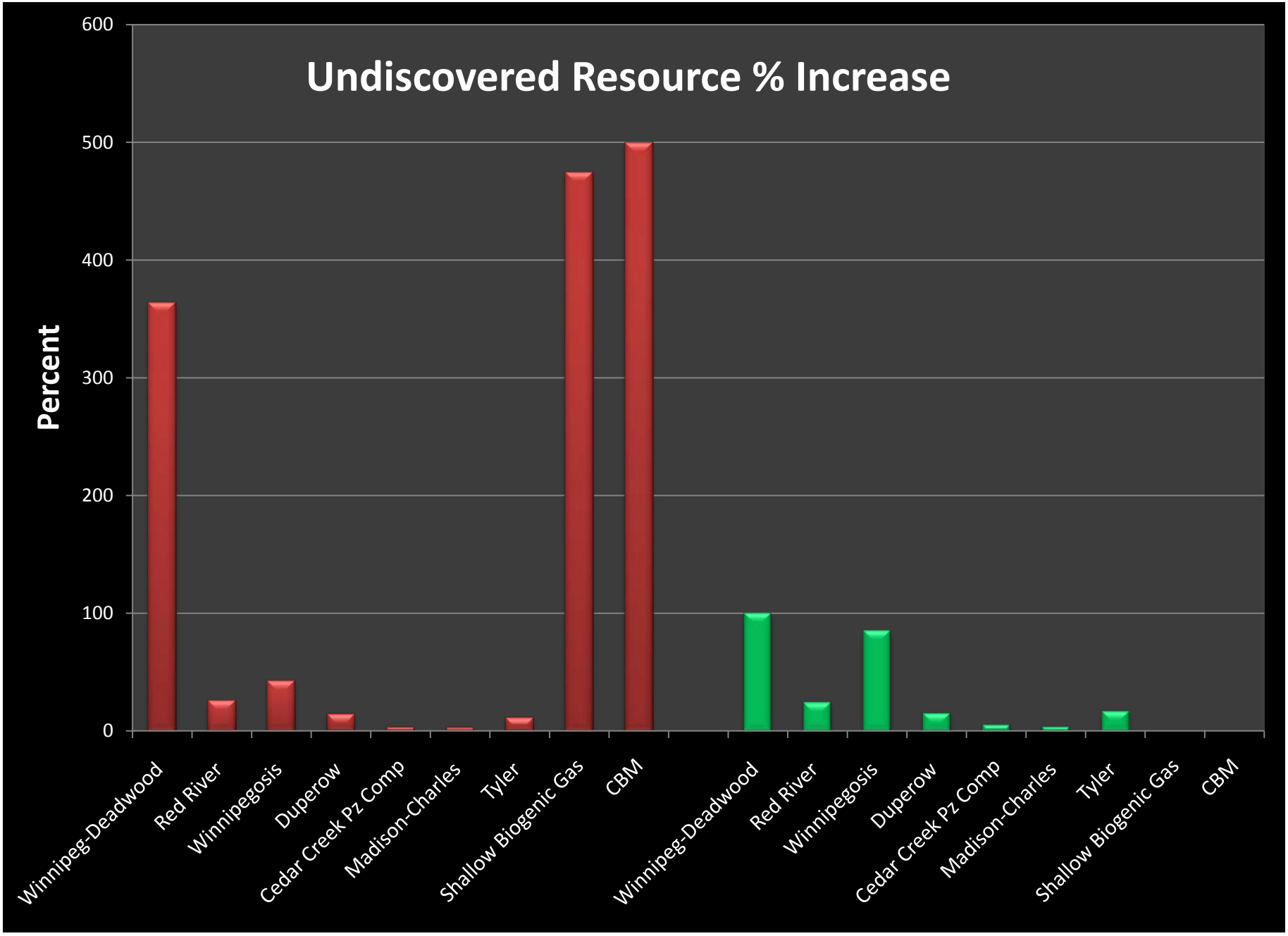

Cedar Creek Pz Composite TPS
OIL (mmbo) and GAS (bcfg)
500
450
400
350
300
250
200
150
100
50
0
Oil, MMBO
Gas, BCFG
Nehring known
Nehring grown
NF Undiscov




Notes by Presenter: Tyler Shale hypothetical. Channel sand that feed the delta system.


Shallow Biogenic Gas & CBM
Hypothetical
GAS (bcfg)
1000
900
800
700
600
500
400
300
200
100
0
Nehring known
Nehring grown
NF Undiscov
CBM Undiscov


Williston Basin
New Field Undiscovered Resources
by TPS (excludes Bakken)
OIL, mmbo
GAS, bcfg
60
50
40
30
20
10
0
1000
900
800
700
600
500
400
300
200
100
0
Winnipeg-Deadwood
Red River
Winnipegosis
Duperow
Cedar Creek Pz Comp
Madison-Charles
Tyler
Winnipeg-Deadwood
Red River
Winnipegosis
Duperow
Cedar Creek Pz Comp
Madison-Charles
Tyler
Shallow Biogenic Gas
CBM


Undiscovered Resource % Increase
Percent
600
500
400
300
200
100
0
Winnipeg-Deadwood
Red River
Winnipegosis
Duperow
Cedar Creek Pz Comp
Madison-Charles
Tyler
Shallow Biogenic Gas
CBM
Winnipeg-Deadwood
Red River
Winnipegosis
Duperow
Cedar Creek Pz Comp
Madison-Charles
Tyler
Shallow Biogenic Gas
CBM

# Conclusions – Williston Basin Assessment

- **Geology based**
- **Calculate technically recoverable undiscovered resources (new field discovery)**
- **Define Total Petroleum Systems & associated Assessment Units (reservoirs)**

- **Undiscovered Technically Recoverable (mean)**
  - **Include Bakken: 3,844 MMBO; 3.70 TCF**
  - **Without Bakken: 199 MMBO; 1.86 TCF**

  - **Does not include reserve growth.**

**Fact Sheets, Posters, GIS data, Future Publications:**
**www.energy.cr.usgs.gov/oilgas/noga/**

Notes by Presenter: Our assessments are geology based.

## Selected References

Kohm, J.A. and R.O. Louden, 1978, Ordovician Red River of eastern Montana and western North Dakota; relationships between lithofacies and production, p. 99-117.