

# **Williston Basin and Paris Basin, Same Hydrodynamics, Same Potential for Unconventional Resources?\***

**Jean-Yves Chatellier<sup>1</sup> and Mark Urban<sup>1,2</sup>**

Search and Discovery Article #10291 (2010)

Posted December 31, 2010

\*Adapted from oral presentation at AAPG International Conference and Exhibition, Calgary, Alberta, September 12-15, 2010

<sup>1</sup>Talisman Energy Inc, Calgary, AB, Canada ([Jchatellier@talisman-energy.com](mailto:Jchatellier@talisman-energy.com); [jeanch@usa.net](mailto:jeanch@usa.net))

<sup>2</sup>University of Regina, Regina, SK, Canada

## **Abstract**

In the early eighties, a surge in the number of discoveries of conventional oil in the Rhaetian sandstones of the Paris Basin can be linked to John Brewster's Williston Basin analogy. The hydrodynamics were seemingly the same and a "per descendum" migration process was invoked in both cases. The hydrocarbon migrates downward because of the sealing capacity of the shales; it then migrates laterally in the underlying strata where local traps and sizeable fields have been found.

The similarity between both basins could possibly be extended to unconventional oil deposits. The Bakken Formation is a "hot play" for horizontal wells targeting a relatively tight sandstone (and carbonate) unit sandwiched between two shales. Those two individual shales are typical of a major transgression overloading a platform that responds by isostatic rebound. They are laterally equivalent to the Exshaw and Besa River Shale in Alberta, where the same dual episode of transgression is recognized. The organic-rich shales are the source rock and the seal for the Bakken play.

In the Paris Basin, the Toarcian shales are the main source rock and are similar in many respects to the Bakken shales. The "schistes Carton" crop out near Besancon in Eastern France and have been recognized as a major oil deposit in the early seventies after major disasters related to construction works (including motorways and buildings). The rock behaved as a sandstone under pressure but as a slate when the overburden was removed. The civil engineering nightmares, leading to the understanding of the schistes Carton, is described to illustrate the nature of this unconventional play.

The central part of the Paris Basin is now the focus of renewed exploration as industry is starting to understand the similarity with the Bakken Play. Numerous wells targeting the Rhaetian sandstones have provided extensive coverage of the Liassic interval where the prospective "Banc de Roc" limestone is sandwiched between the Lower Domerian shales and the Toarcian shales of the Schistes Carton.

Analogy with other transgressive shales and source rocks in intracratonic basins is made.

## References

Bacchiana, C., J. Parpant, and B. Smart, 1994, Management of Chaunoy oil field multilayered reservoir: European Association of Petroleum Geoscientists, Special Publication.v. 4, p. 147-153.

Bachu, S. and B. Hitchon, 1996, Regional-scale flow of formation waters in the Williston Basin: AAPG Bulletin, v. 80/2, p. 248-264.  
Bessereau, G., F. Guillocheau, and A.Y. Huc, 1995, Source rock occurrence in a sequence stratigraphic framework; the example of the Lias of the Paris Basin: AAPG Studies in Geology, v. 40, p. 273-301.

Caplan, M.L., 1997, Factors Influencing the Formation of Organic-Rich Sedimentary Facies: Example from the Devonian-Carboniferous Exshaw Formation, Alberta, Canada: University of British Columbia, Vancouver, BC, Canada, Ph.D thesis, 688 p.

LeFever, J.A., 2005, Williston Basin correlation cross-section: Bakken Formation, *in* Geologic Investigations (NDGS), No. 14: North Dakota Geological Survey Internet resource, Web accessed 29 December 2010  
<http://www.library.nd.gov/statedocs/GeologicalSurvey/Willistonbasinpostersession20050502.pdf>

LeFever, J.A., and S.H. Nordeng, 2009, The Three Forks Formation, North Dakota to Sinclair Field, Manitoba, *in* Geologic Investigations (NDGS), No. 76: North Dakota Geological Survey Internet resource, Web accessed 29 December 2010  
<http://www.library.nd.gov/statedocs/GeologicalSurvey2/GI-76-20091202.pdf>

Perrodon, A. and J. Zabek, 1990, Paris Basin, *in* Interior Cratonic Basins: AAPG Memoir 51, p. 633-679

Ross Smith Energy Group, Ltd. (RSEG), 2010, Technology drives future growth (Bakken update), *in* June 15, 2010 report: Web accessed 29 December 2010,  
[http://webcache.googleusercontent.com/search?q=cache:Q8fIyBru7EcJ:www.rseg.com/main/sites/default/files/reports/Kodiak\\_08\\_10RSEG.pdf+rseg+june+15+2010+technology+drives+future+growth&cd=1&hl=en&ct=clnk&gl=us&client=firefox-a](http://webcache.googleusercontent.com/search?q=cache:Q8fIyBru7EcJ:www.rseg.com/main/sites/default/files/reports/Kodiak_08_10RSEG.pdf+rseg+june+15+2010+technology+drives+future+growth&cd=1&hl=en&ct=clnk&gl=us&client=firefox-a)

## Websites

Paris Basin Database: Web accessed 29 December 2010  
[http://www.metstor.fr/IMG/jpg/coupe\\_du\\_bassin\\_parisien.jpg](http://www.metstor.fr/IMG/jpg/coupe_du_bassin_parisien.jpg)

USGS, 2009, Energy Resources Program Geochemistry Data Base: Web accessed 29 December 2010  
<http://energy.cr.usgs.gov/prov/og/data2.htm>

# Williston Basin and Paris Basin

Same hydrodynamics,  
Same potential for unconventional resources?

Jean-Yves Chatellier

Talisman Energy Inc

Mark Urban

University of Regina  
and Talisman Energy Inc

# Talk outline

Tight reservoirs sandwiched between two shales

Bakken – Exshaw (Williston Basin)

Schiste Carton (Paris Basin)

Analogy between the two basins

Conventional reservoirs and “Per Descendum Migration”

Unconventional reservoirs

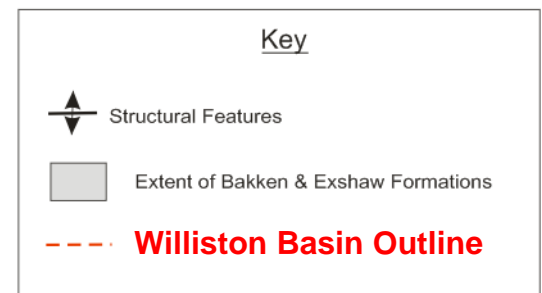
Conclusions

# Exshaw – Bakken Sandwich

Devonian-Mississippian  
Western Canada

# Exshaw / Bakken

## One big transgression



# Exshaw Type section

Jura Creek, Alberta





# The Exshaw three members

Nordegg (city), Alberta

Upper  
Shales

Middle  
Member

Lower  
Shales

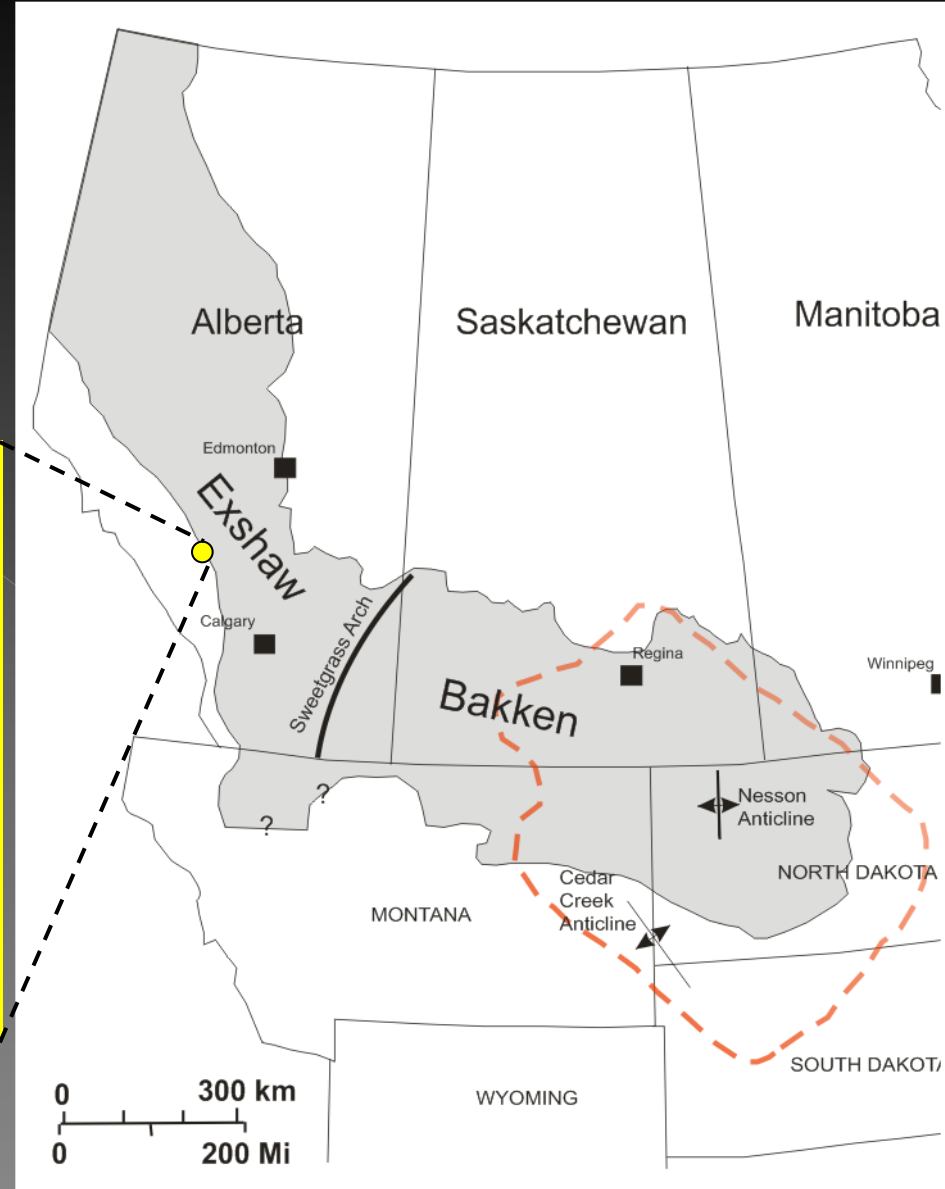
Palliser



Top

Bottom

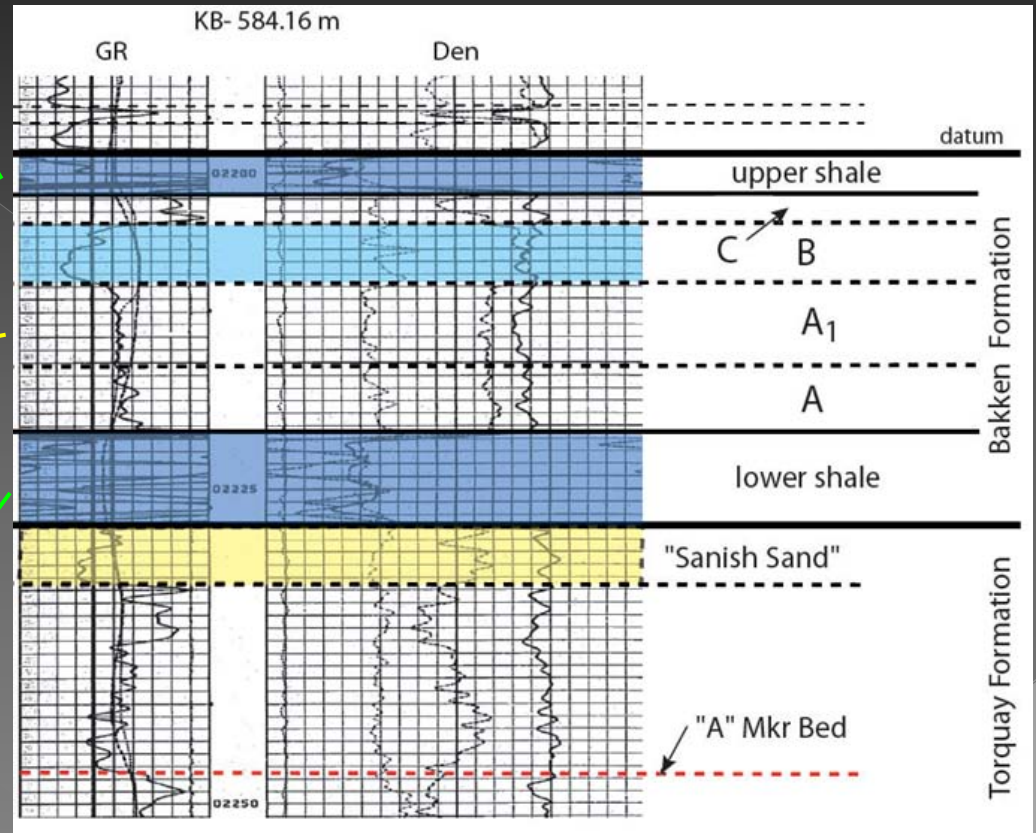
Series overturned





# Bakken Formation

Well log from North Dakota  
in Tableland Field



10-1-2-19W2

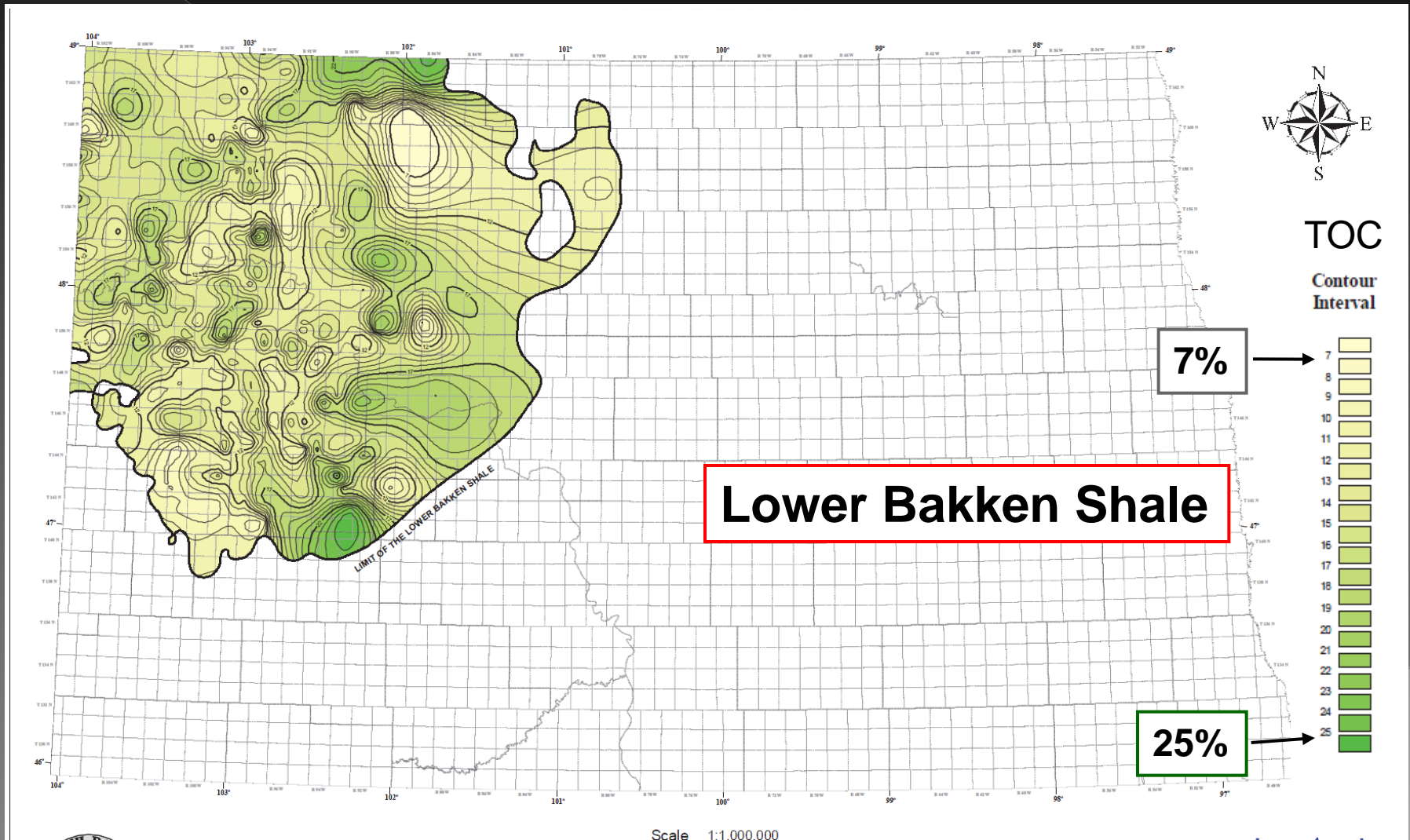
8-11-8-14W2

3-9-6-16W2

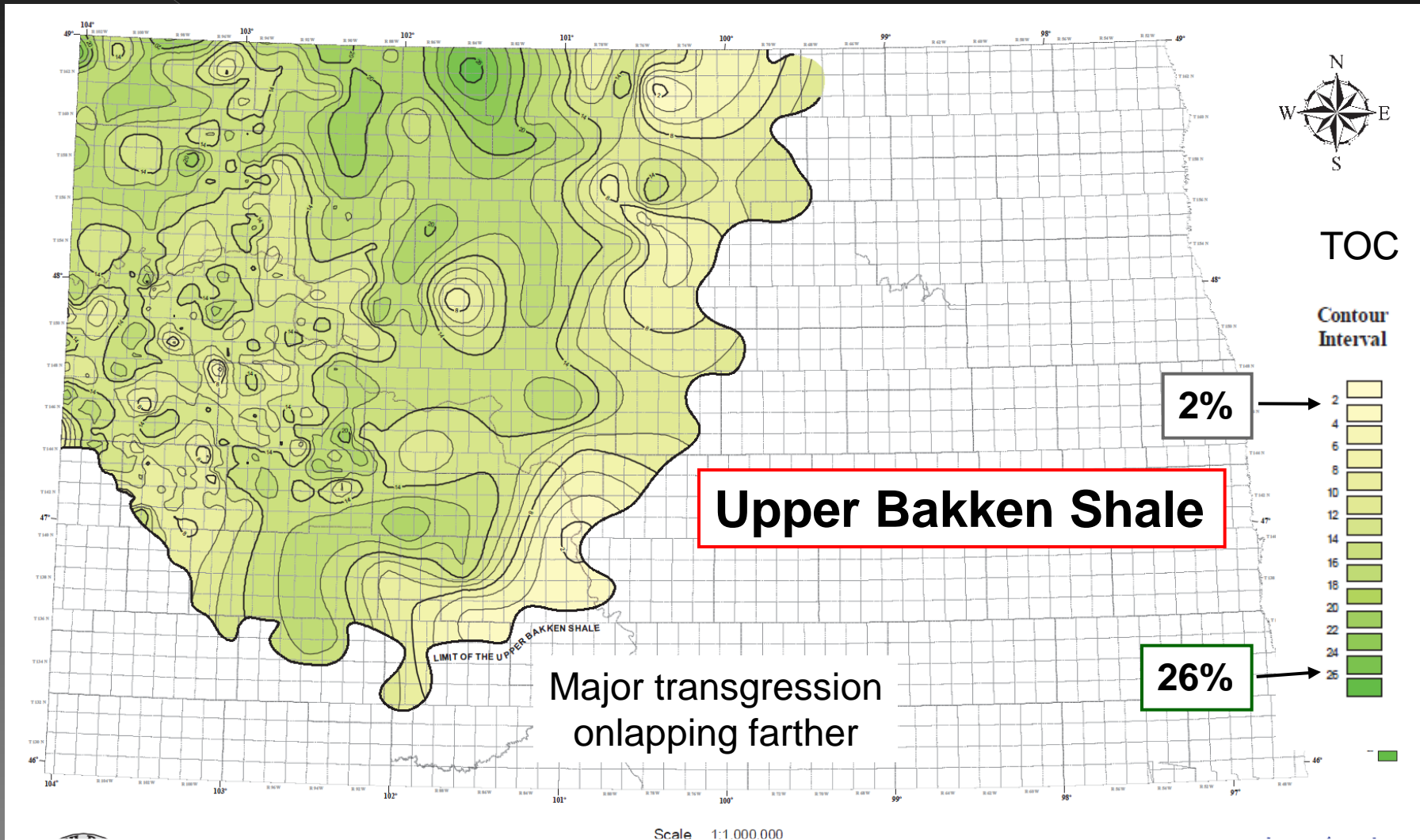
7-12-7-6-11W2

Photos, courtesy Solange Angulo

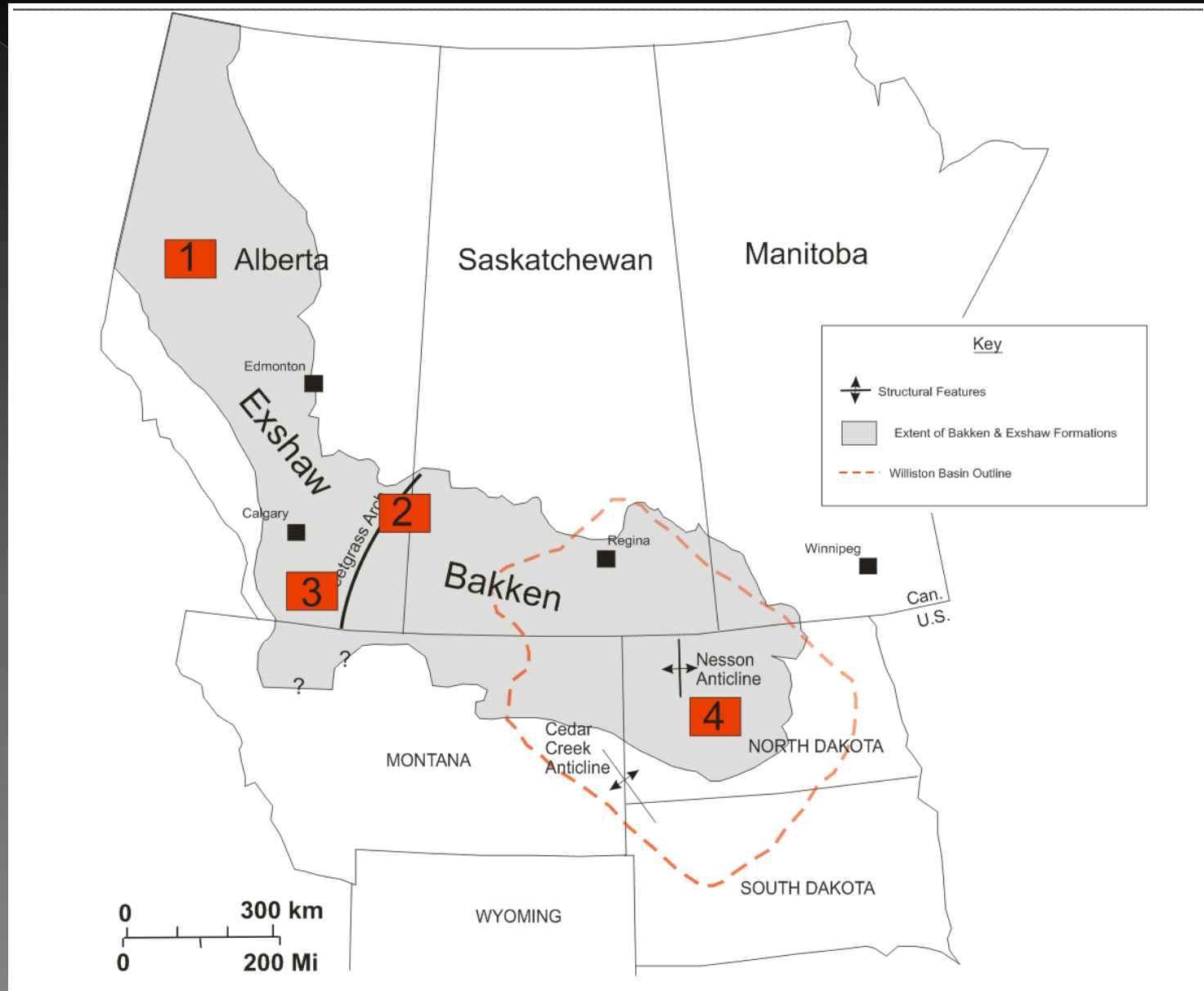
# North Dakota TOC (Total Organic Carbon) Lower Bakken Shale



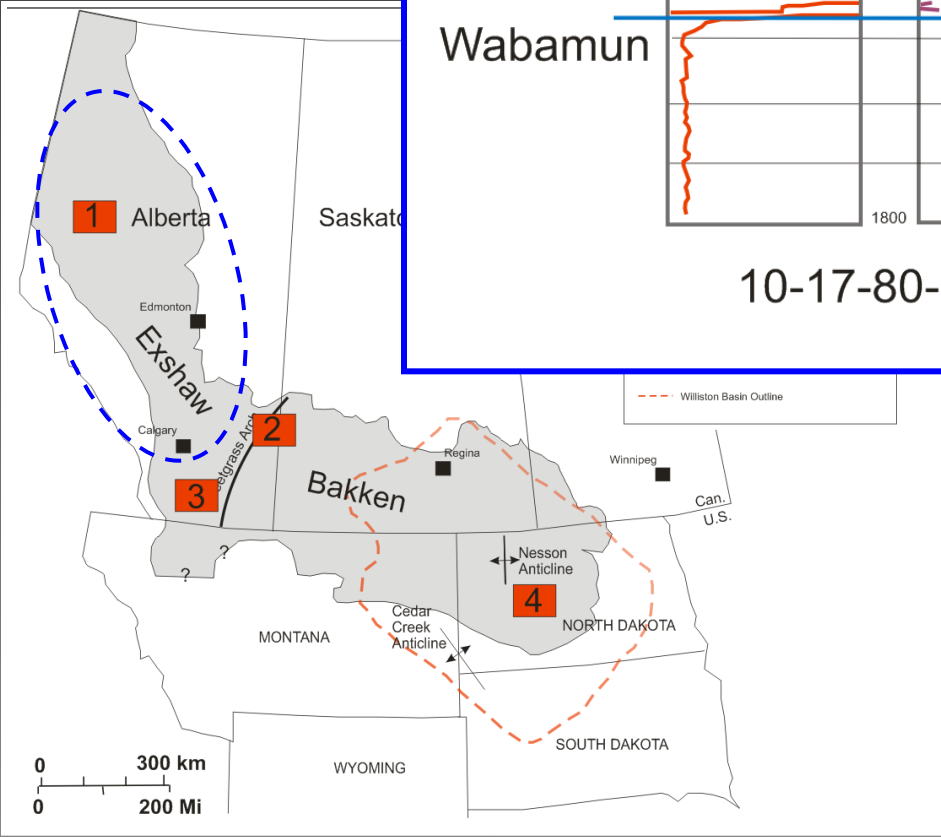
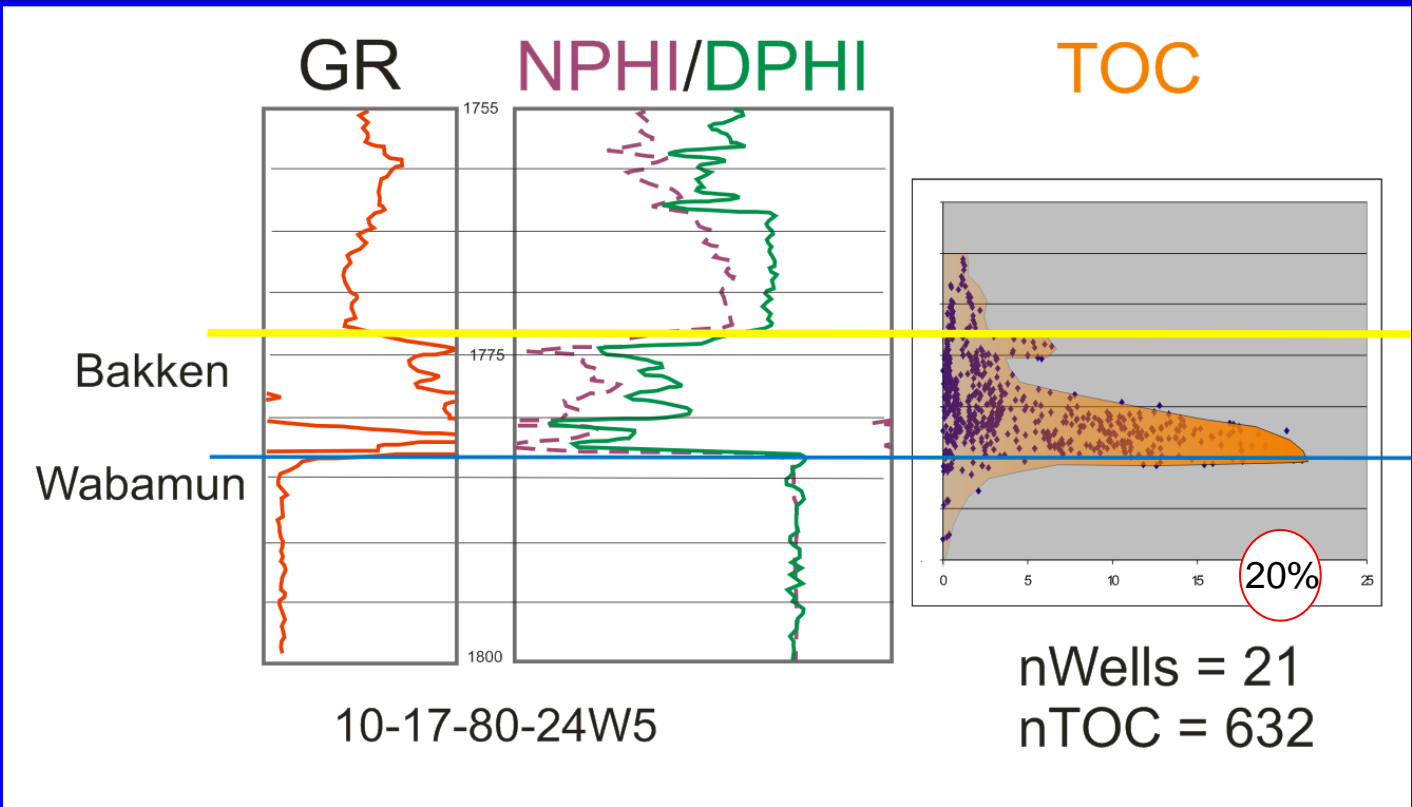
# North Dakota TOC (Total Organic Carbon) Upper Bakken Shale



# Bakken TOC distribution across WCSB



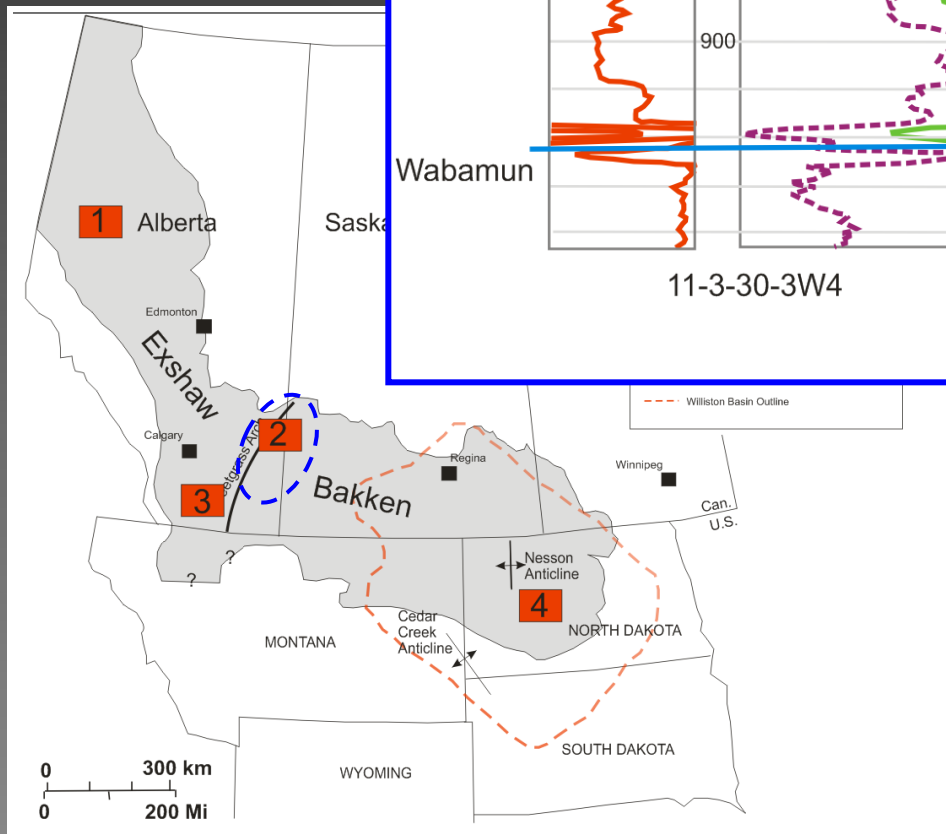
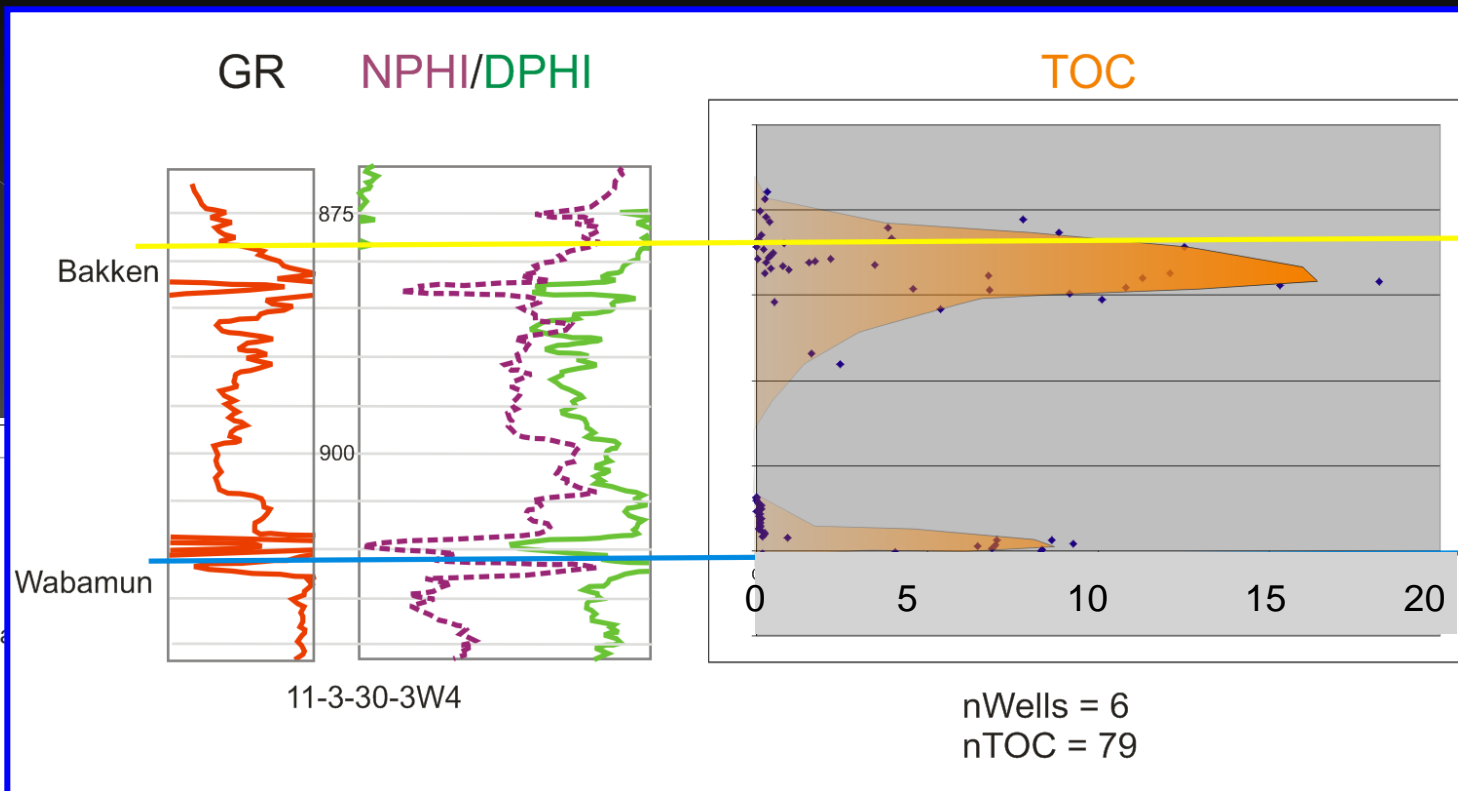
# Area 1



TOC data: **Caplan, Mark L. (1997)**, *Factors Influencing the Formation of Organic-Rich Sedimentary Facies: Example from the Devonian-Carboniferous Exshaw Formation, Alberta, Canada; unpubl. Ph.D thesis.*

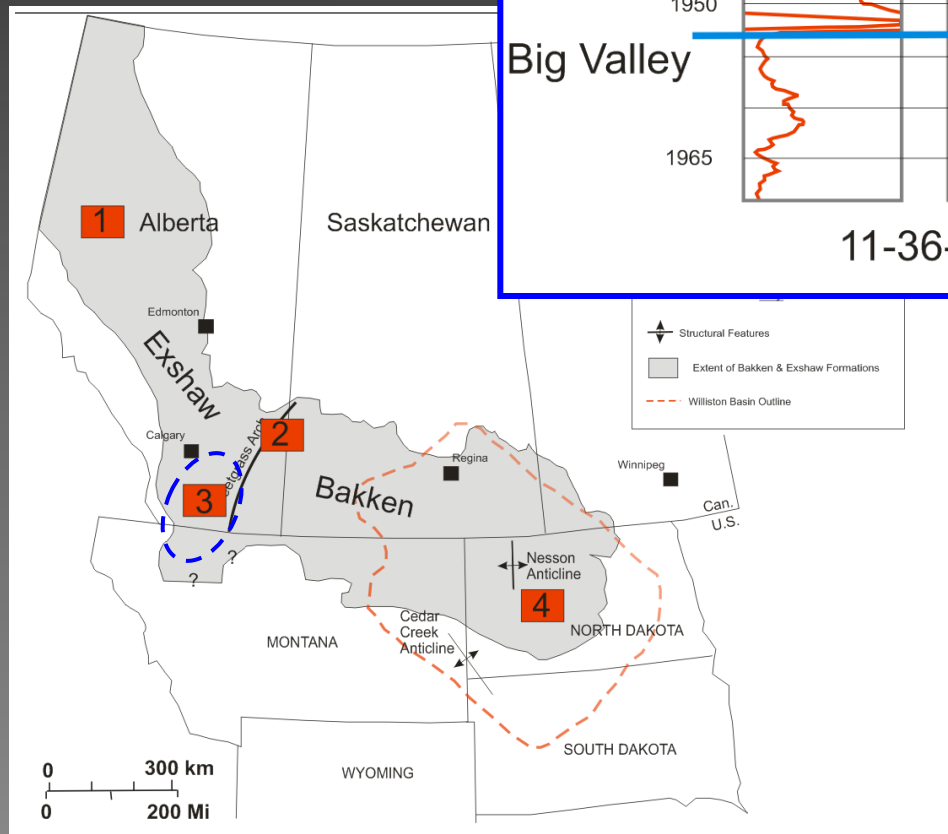
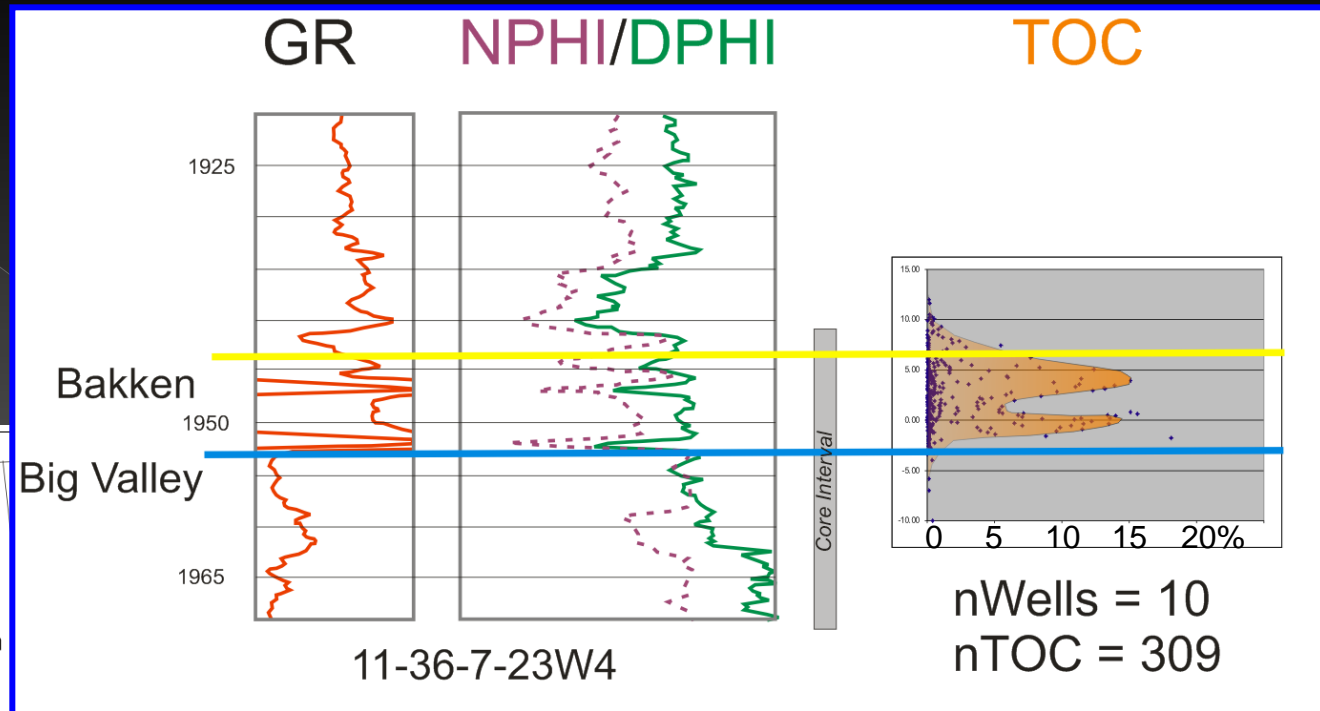


# Area 2



TOC data: **Caplan, Mark L. (1997)**, *Factors Influencing the Formation of Organic-Rich Sedimentary Facies: Example from the Devonian-Carboniferous Exshaw Formation, Alberta, Canada; unpubl. Ph.D thesis.*

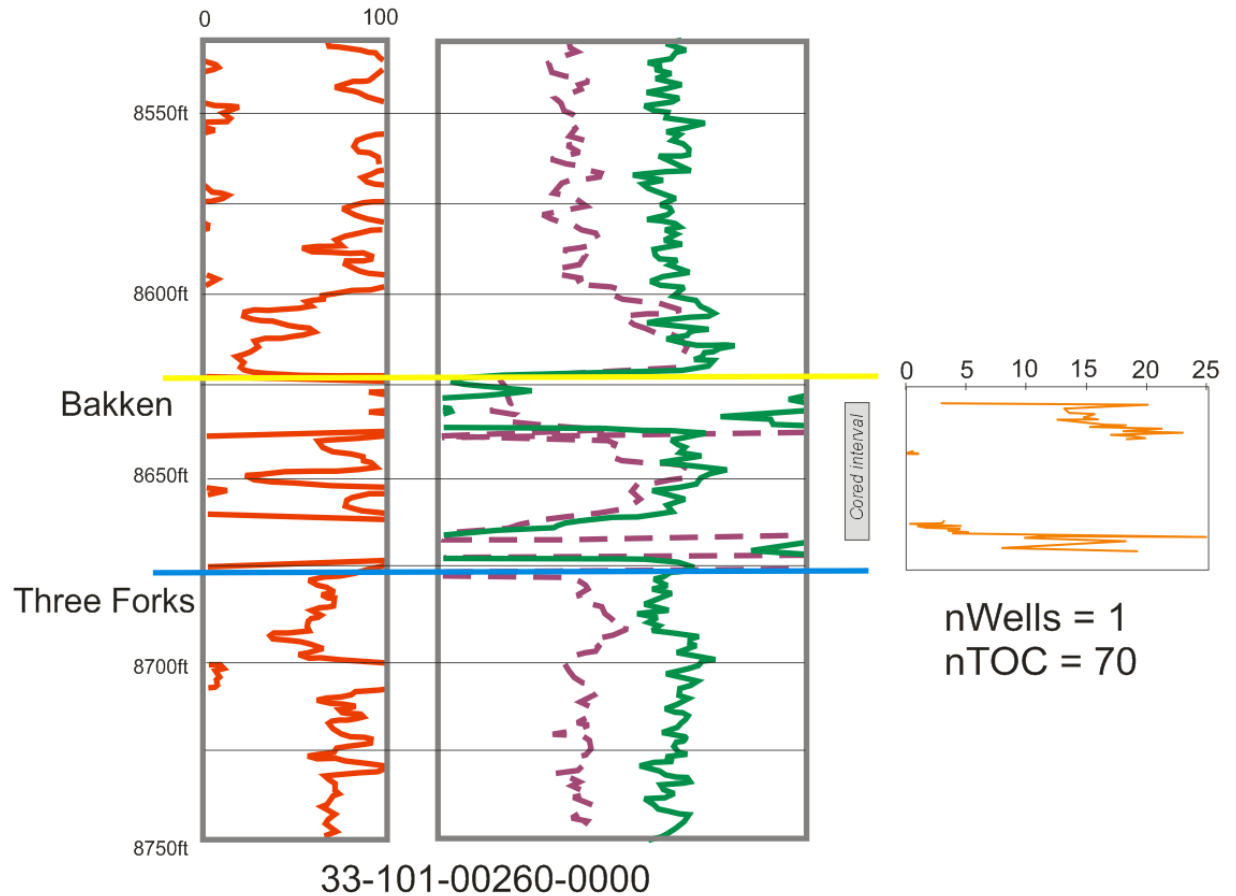
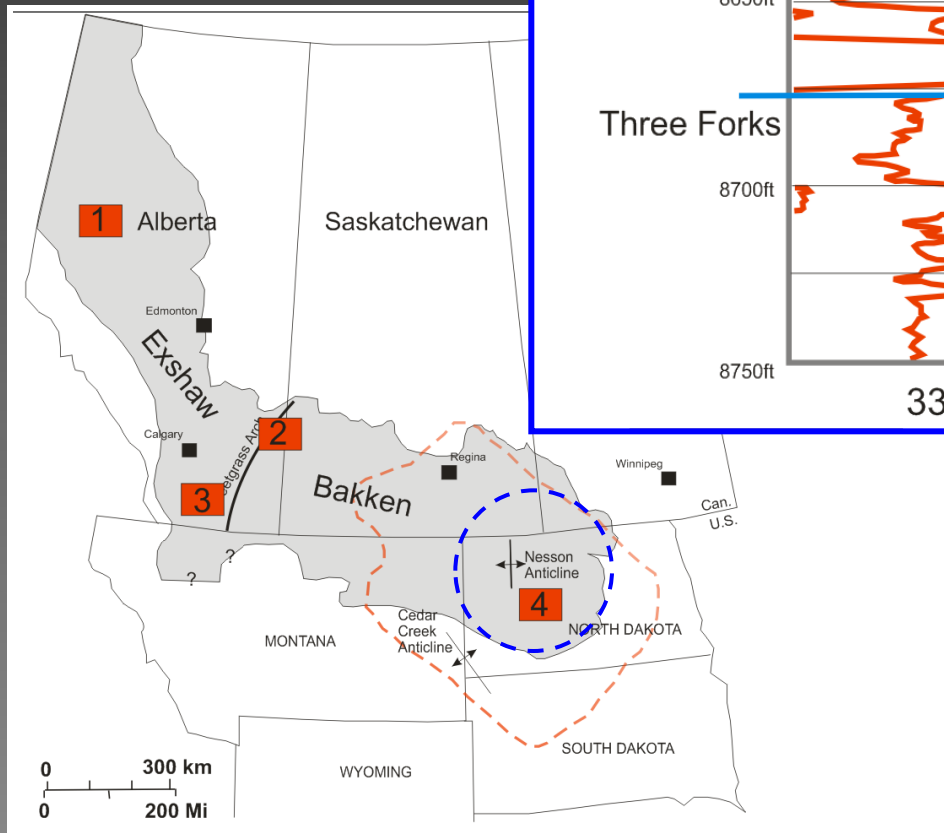
# Area 3



TOC data: **Caplan, Mark L. (1997)**, *Factors Influencing the Formation of Organic-Rich Sedimentary Facies: Example from the Devonian-Carboniferous Exshaw Formation, Alberta, Canada; unpubl. Ph.D thesis.*



# Area 4



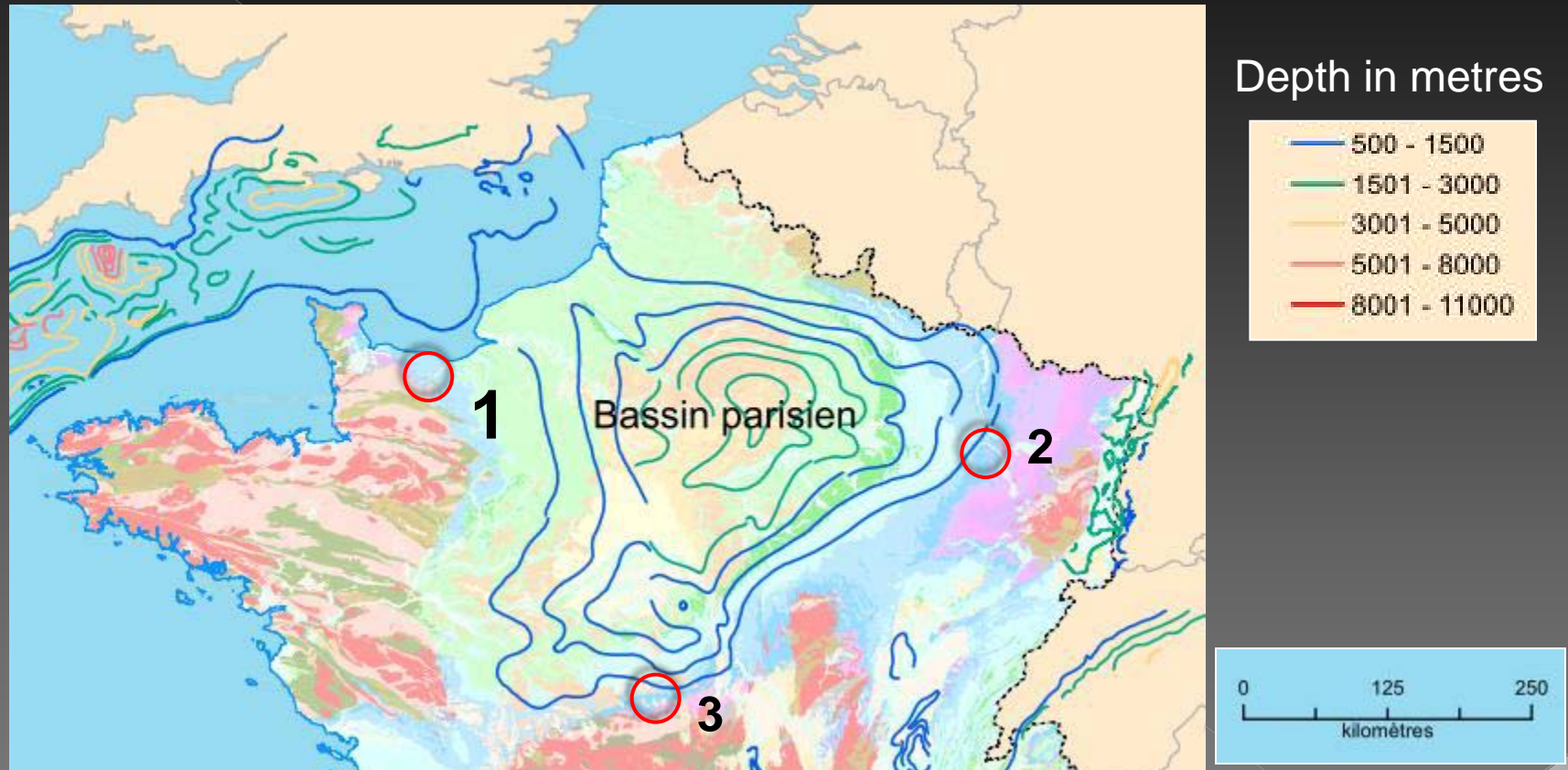
TOC data: [USGS database:](http://energy.cr.usgs.gov/prov/og/data2.htm)  
<http://energy.cr.usgs.gov/prov/og/data2.htm>

# Schistes Carton

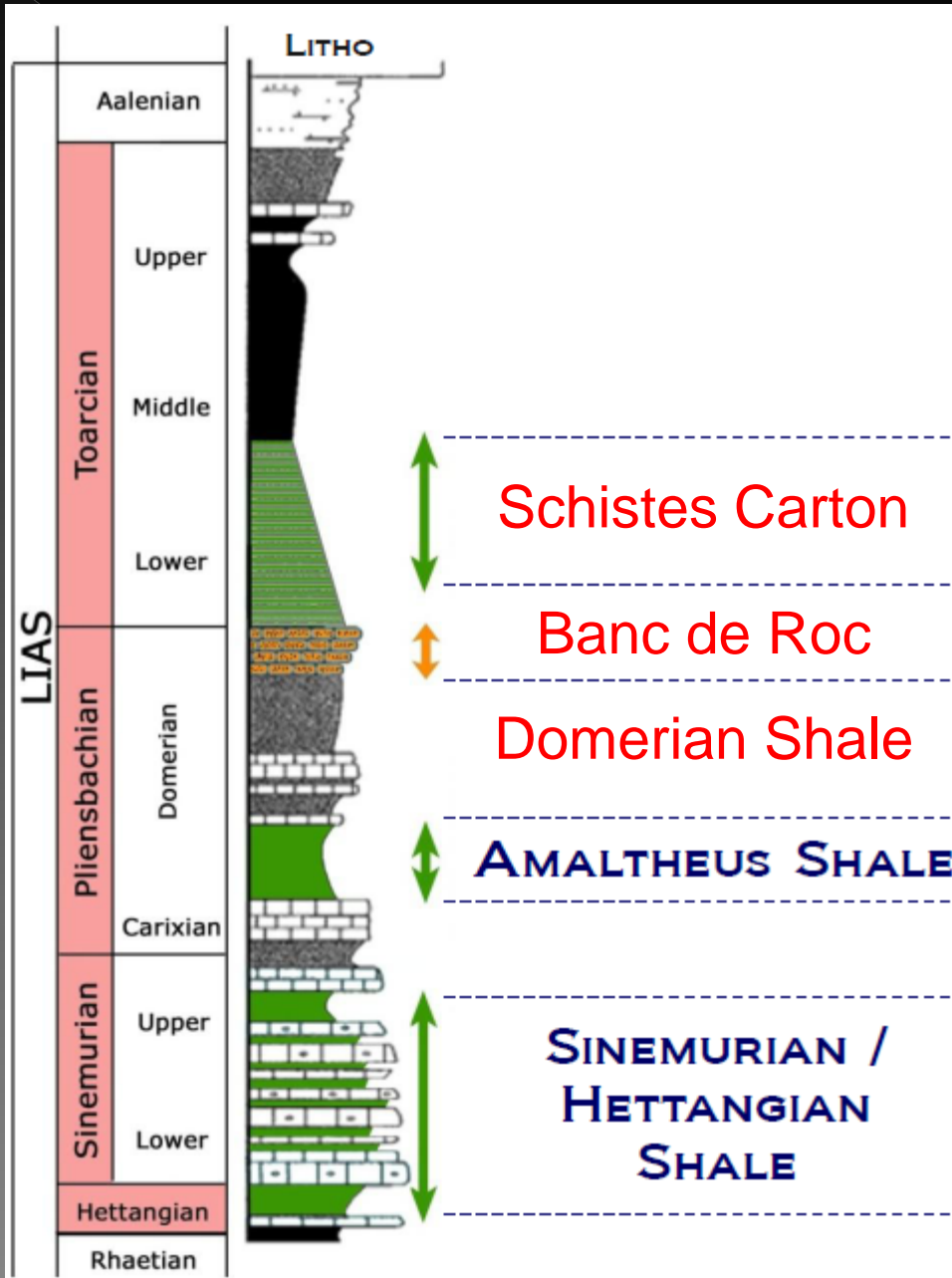
Toarcian Shales

Paris Basin

# Schistes Carton in the Paris Basin



# Liassic Stratigraphy in the Paris Basin



Focus of this talk

After Toreador 2010

# Schistes Carton, a fossil hunter's paradise

Locality #1 Bayeux, Normandy



Hildoceras Bifrons



Belemnite with rostrum

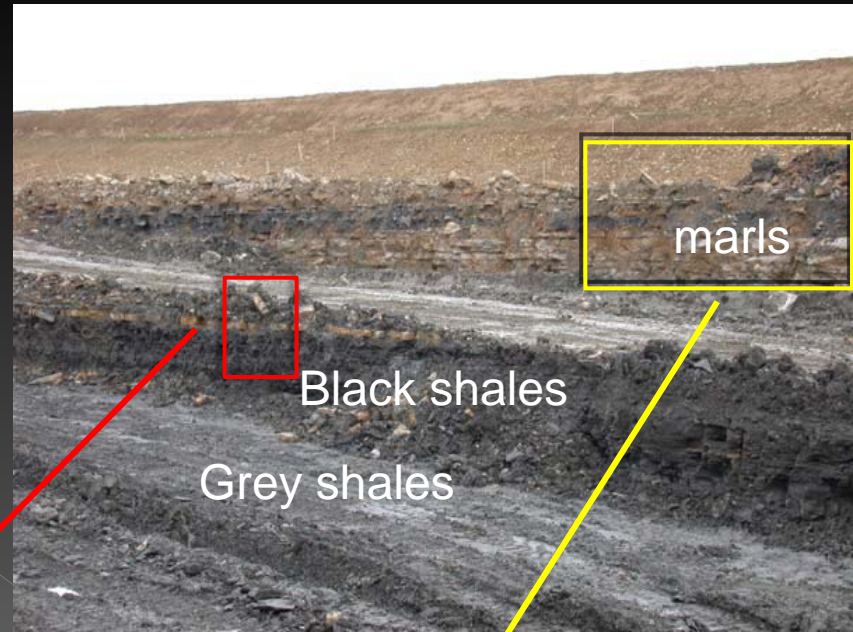


# The fossiliferous Toarcian shales and marls

Western Edge of Paris Basin



Outcrop near Bayeux, Normandy  
Locality #1



Photos courtesy University of Caen

# Details of the shale of the Schistes carton



Photos courtesy University of Caen, France



## “Banc de Roc”

A carbonate sandwiched  
between two shales



Photos courtesy University of Caen, France

## #2 The Civil Engineering Nightmare

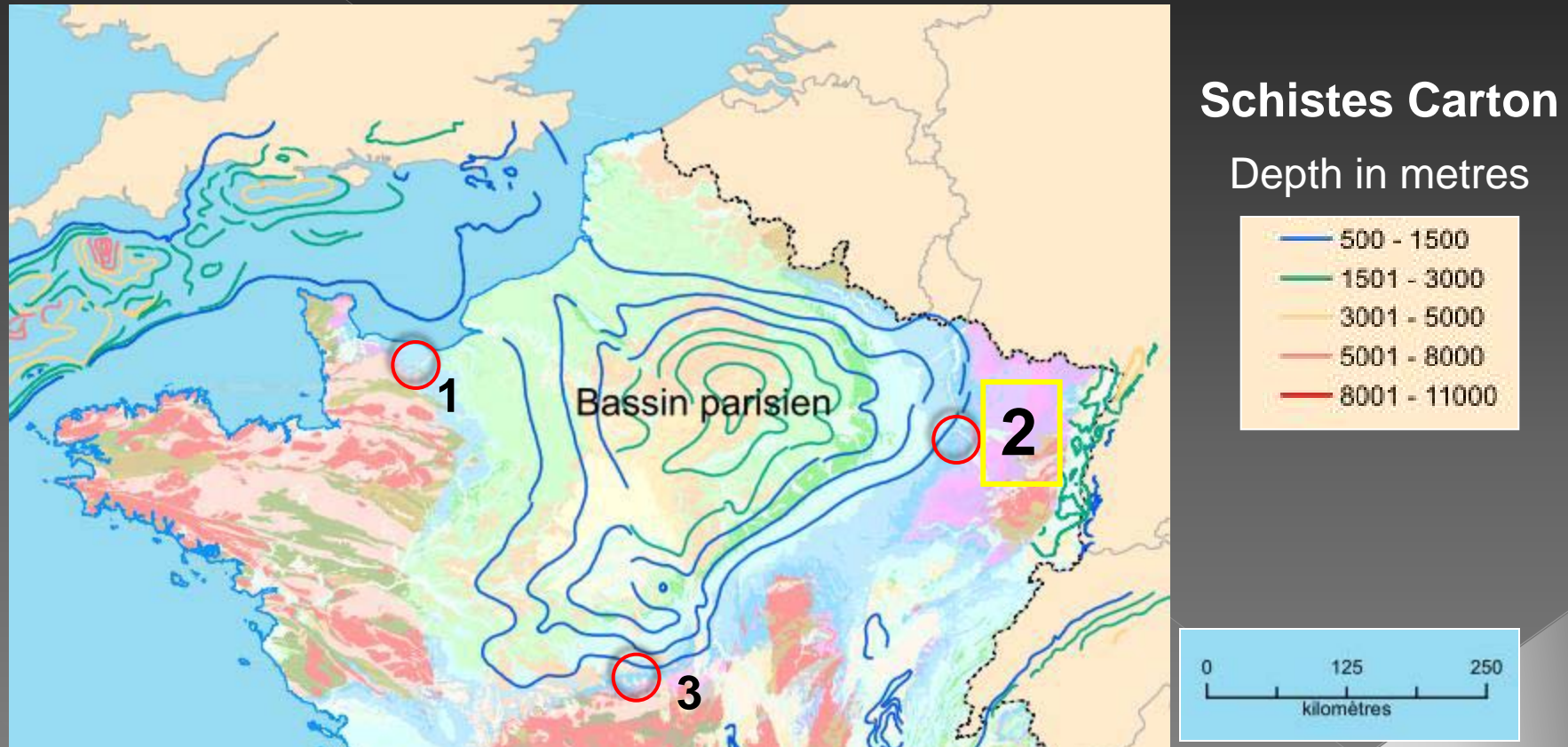


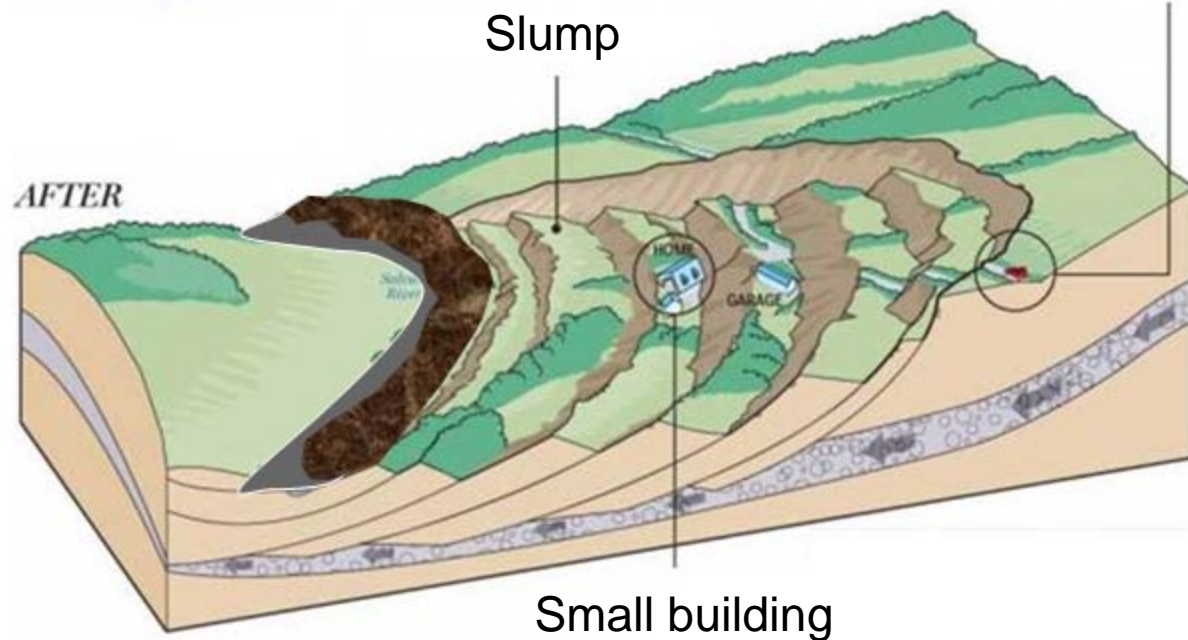
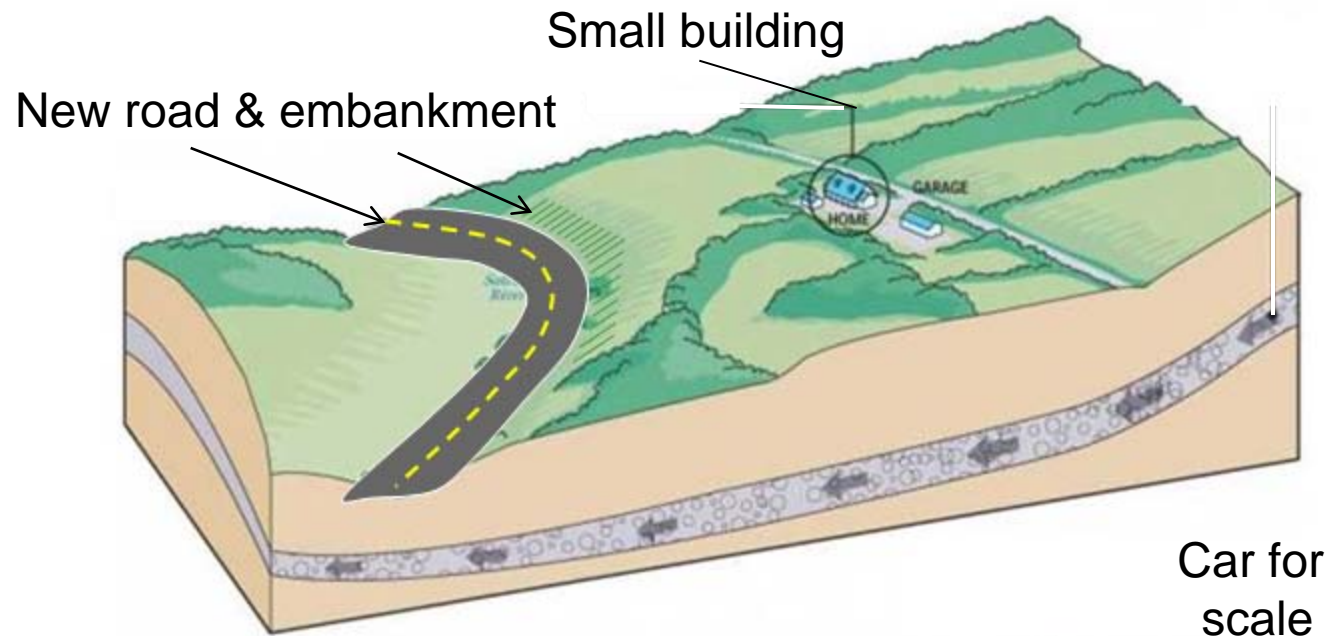






Photo of slump taken from a Quebec event in 2010 (National Post, May 11)





Adapted after National Post, May 11 2010

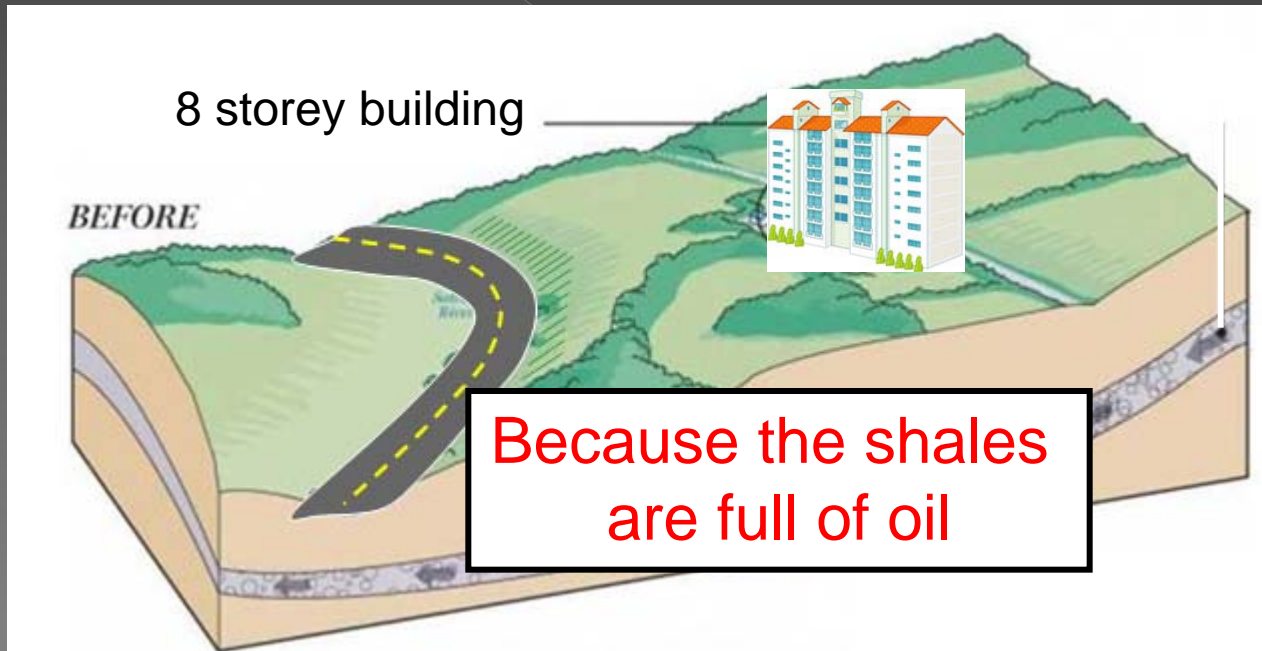
# Now the Civil Engineering Problem

Huge load of the big building

But

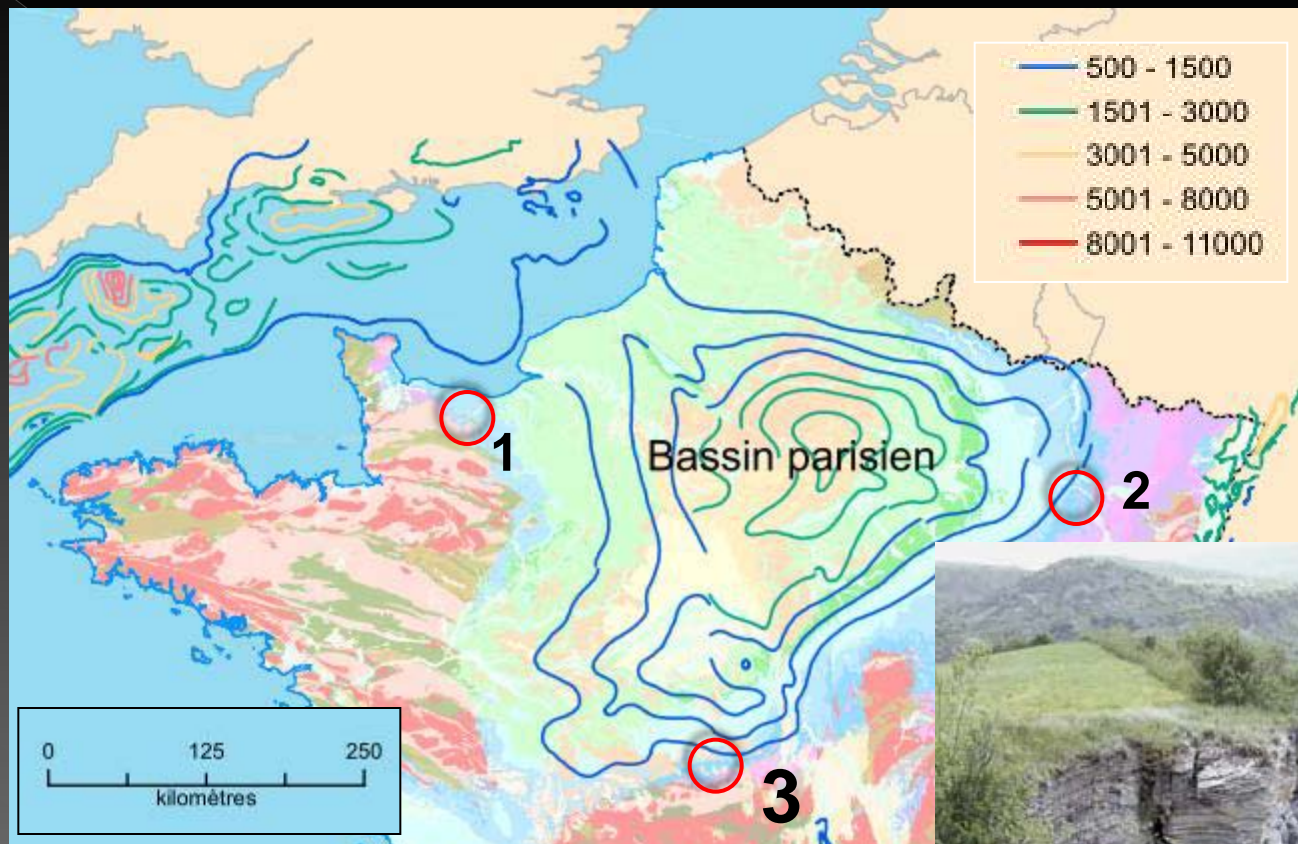
No slump

Why?



Adapted after National Post, May 11 2010





## Schistes Carton

The problem?

It is full of oil !!!

[http://www.metstor.fr/IMG/jpg/coupe\\_du\\_bassin\\_parisien.jpg](http://www.metstor.fr/IMG/jpg/coupe_du_bassin_parisien.jpg)

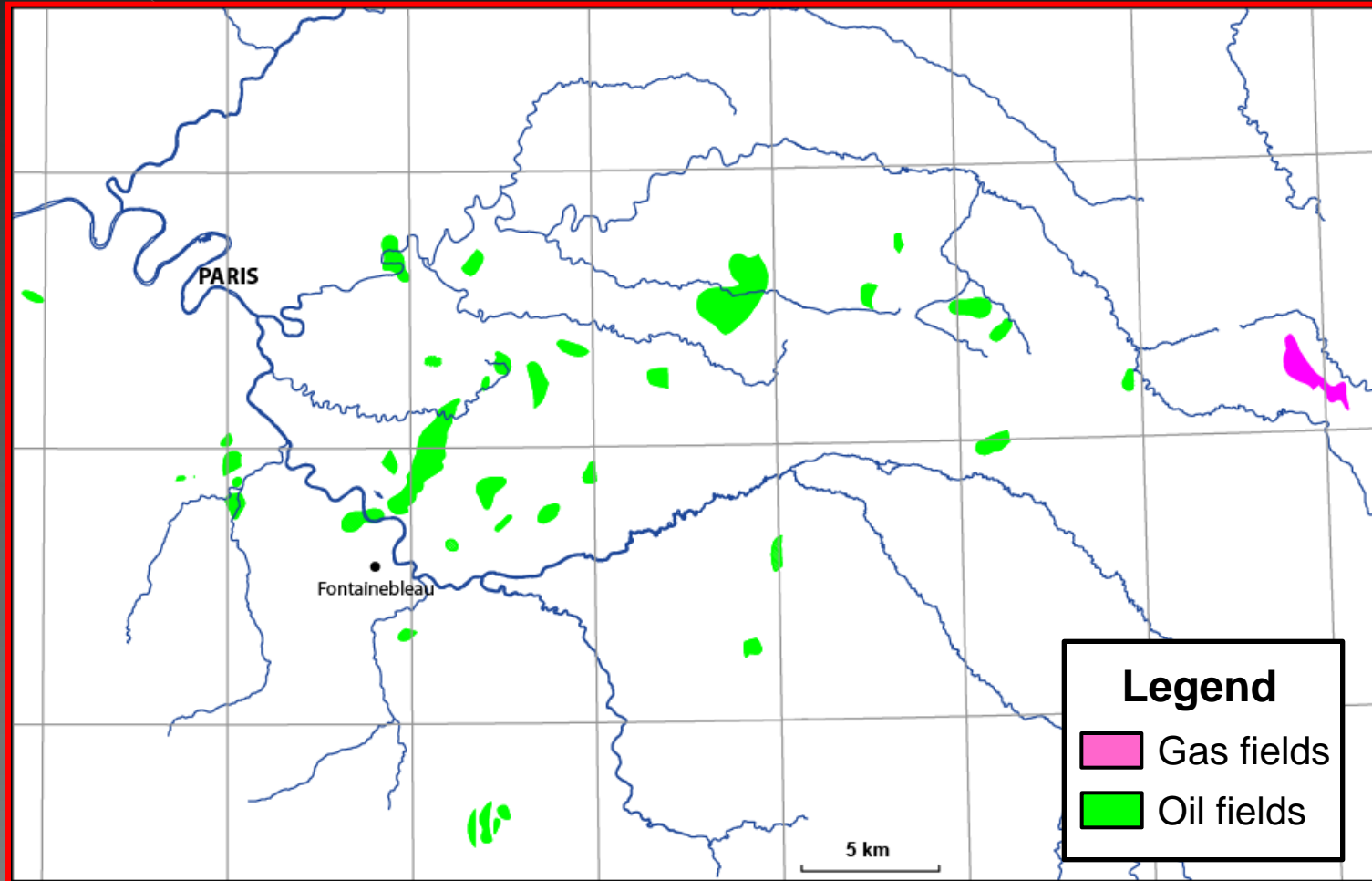
With no overburden, the oil saturated rocks break down into a slate--like pattern ("carton plates").

With overburden, the rock has similar strength properties as a sandstone



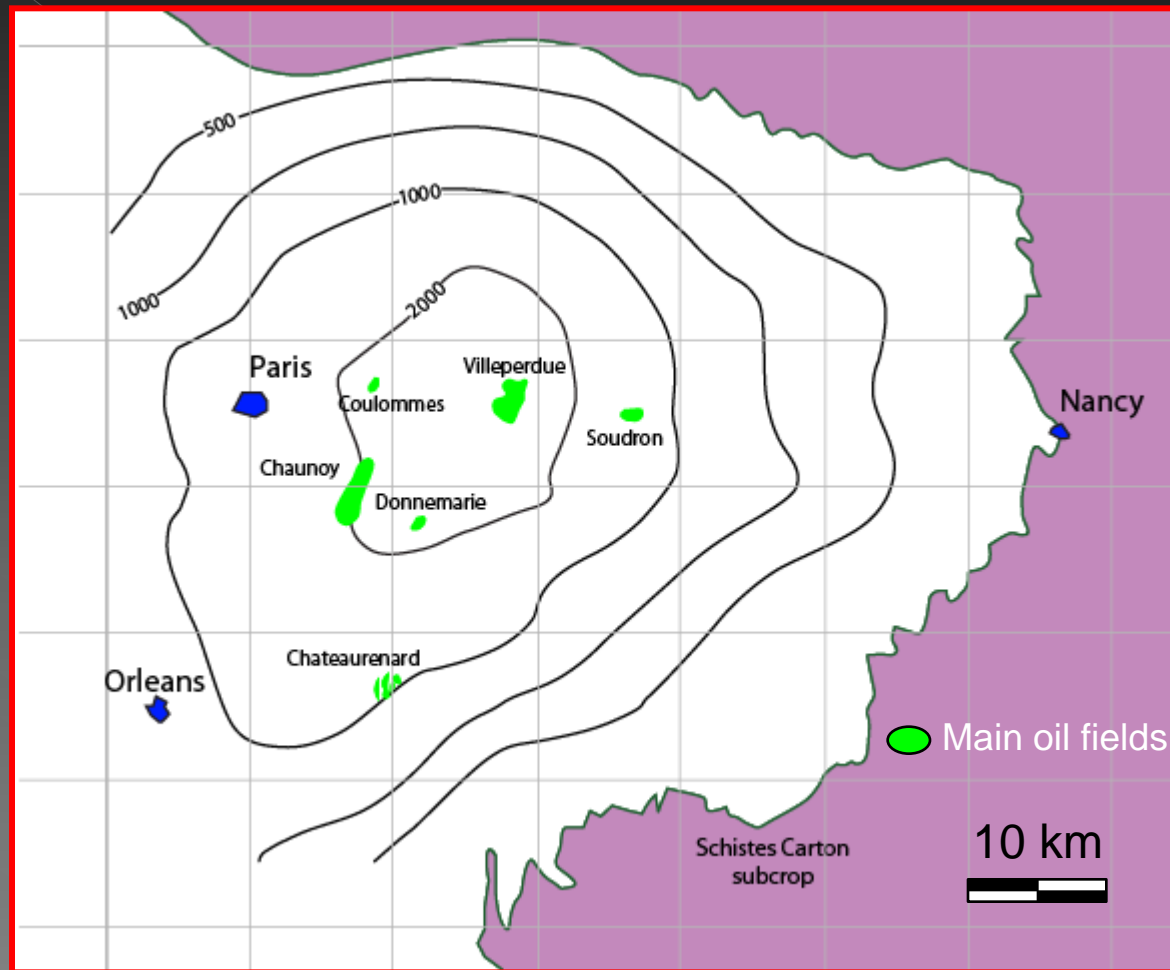


# Paris Basin Oil and Gas Fields



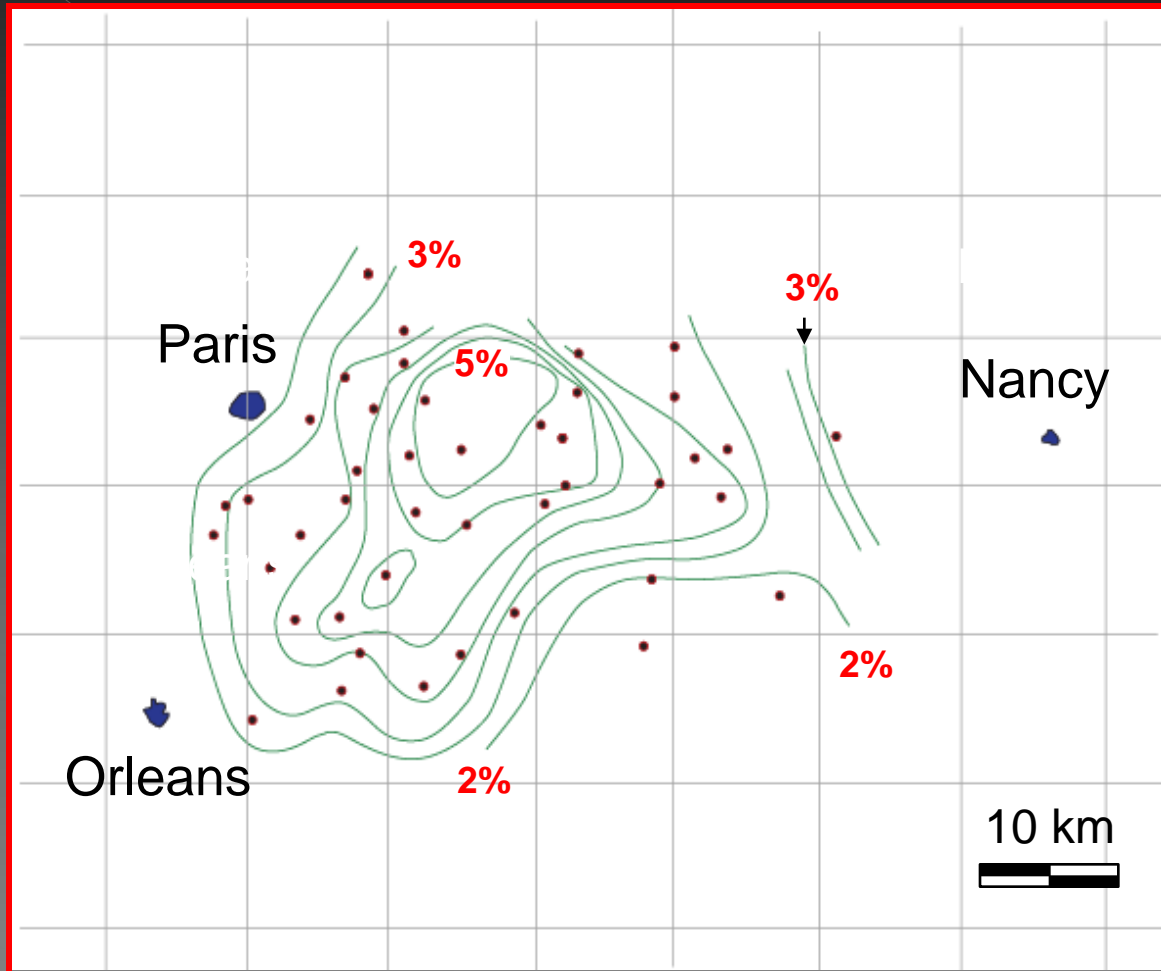
Many fields are in Triassic sandstones

# Depth of Schistes Carton (in metres)



Modified after Bessereau et al. (1995)

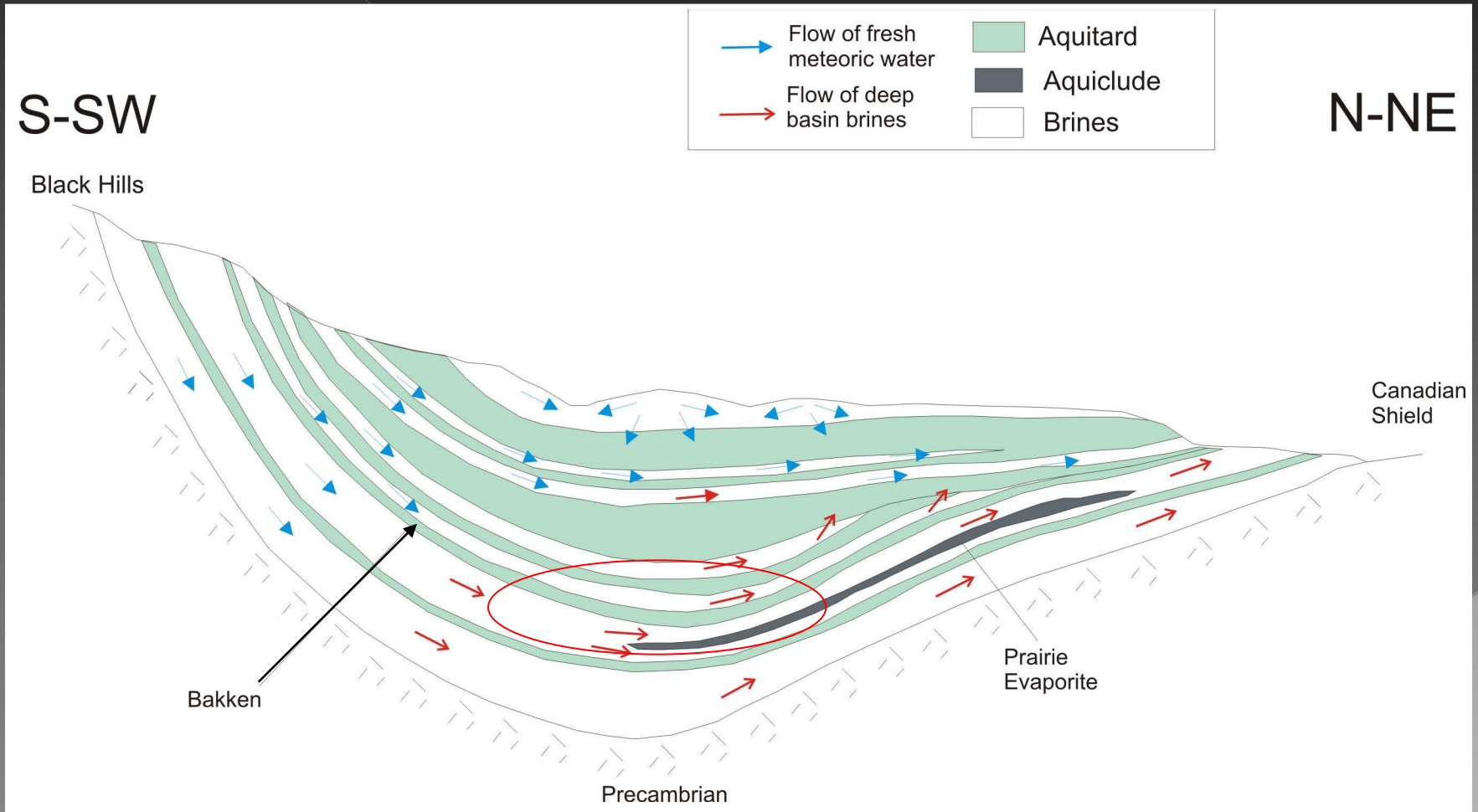
# Total Organic Content of Liassic Schistes Carton



Modified after Bessereau et al. (1995)

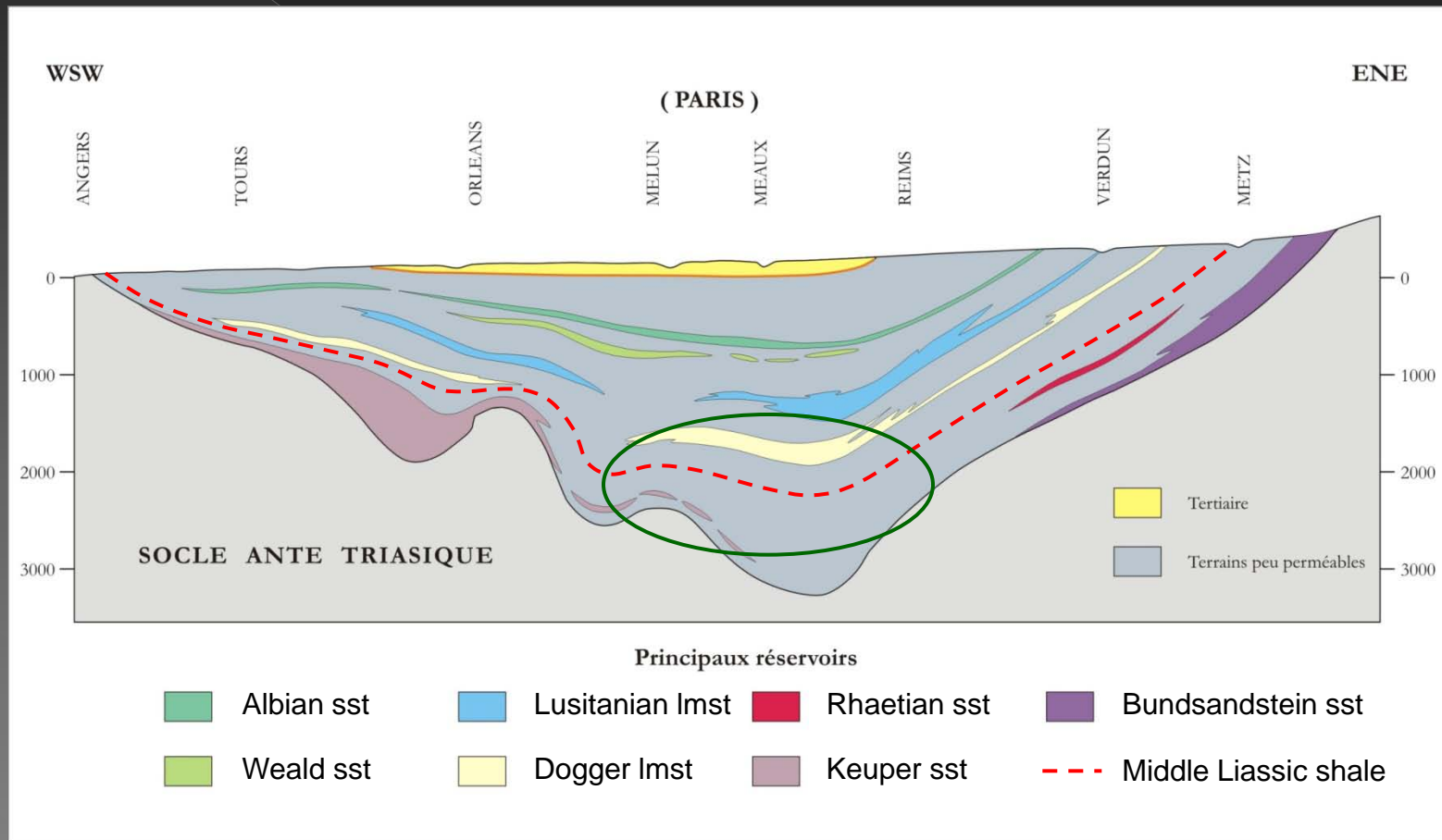
# Basin Hydrodynamics

## Williston Basin Cross-Section



Modified after Bachu and Hitchon 1996

# Paris Basin Cross Section



# Per Descendum Migration

Proposed by French  
Scientists

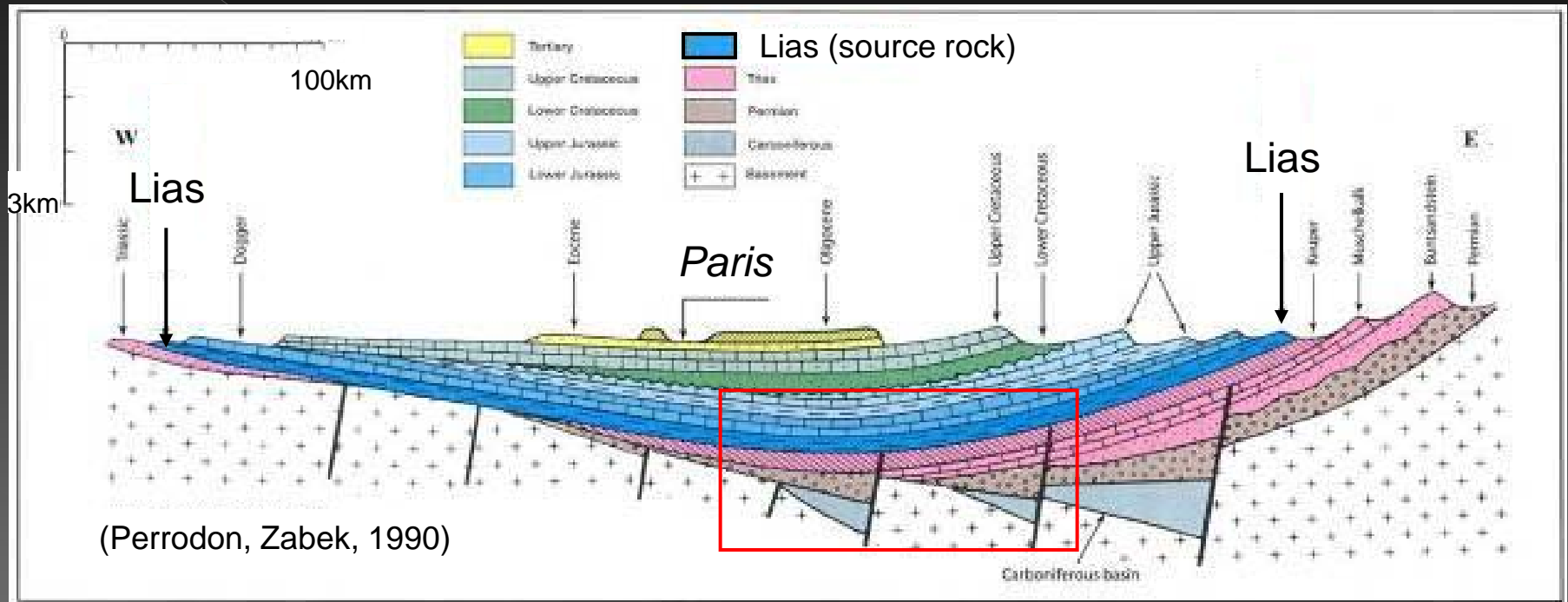
One of the first real example:

**Ozouri Formation** in Gabon  
Late Paleocene – Eocene  
Unconventional siliceous ooze with fractures  
similar to Monterey Formation

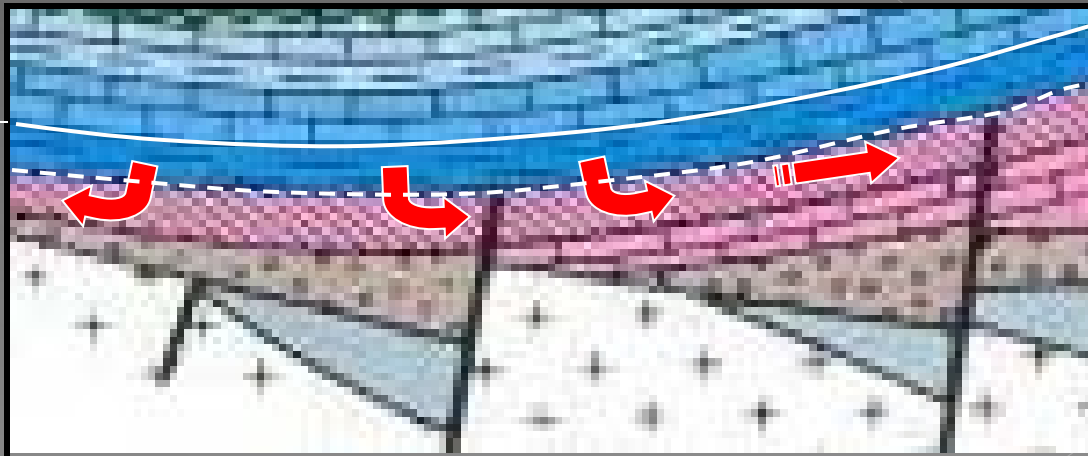
## John Brewster's story

Learned of the hypothetical mechanism in **France** (Esso France /Exxon)  
Applied to **Williston Basin** with success  
Applied later to **Paris Basin** with success

# Per Descendum Migration



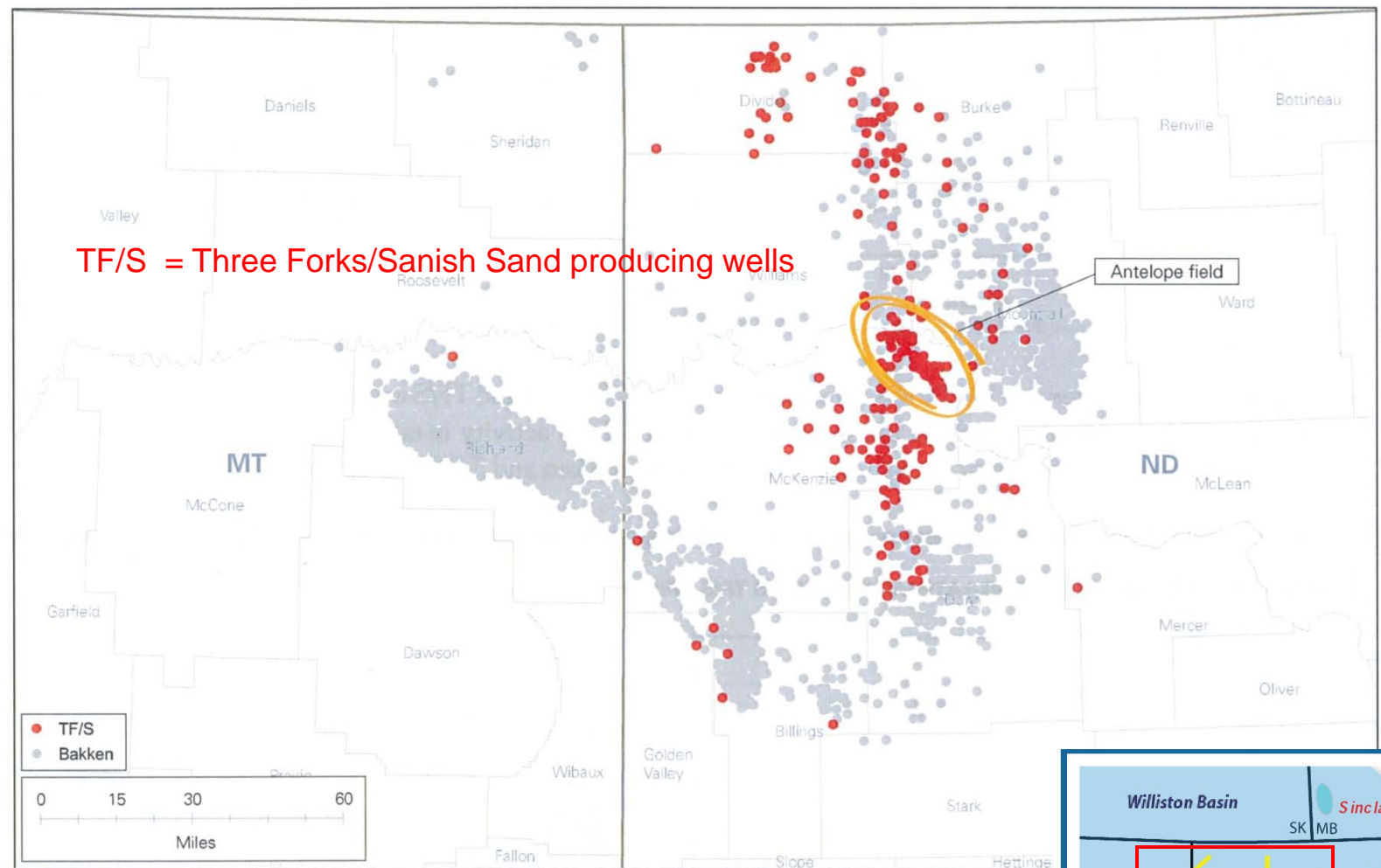
Tight limestone  
Source rock & seal



The upper part of  
the source rock is  
a seal.

Hydrodynamic  
forces pushes the  
oil downward



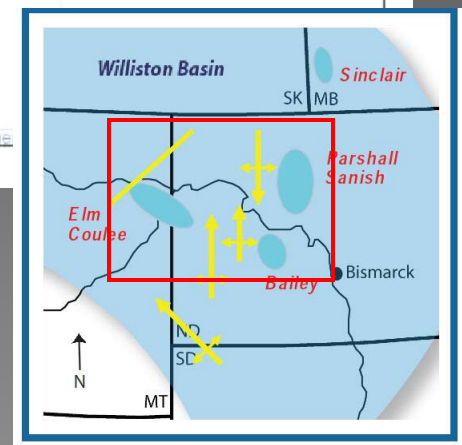


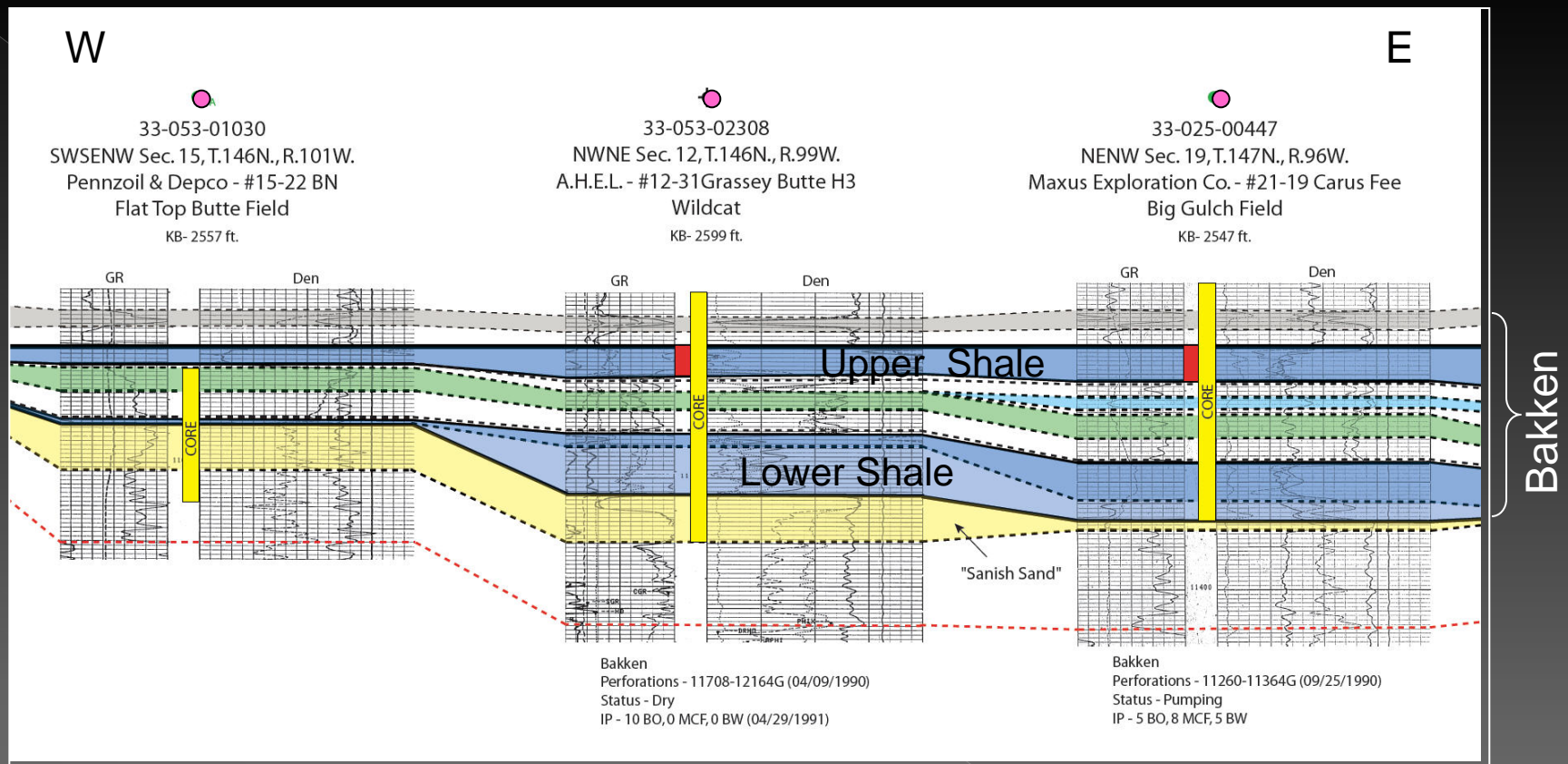
Source: NDIC, HPDI, RSEG

## Examples of Bakken oil downward migration:

### 1) Sanish Sand, ND

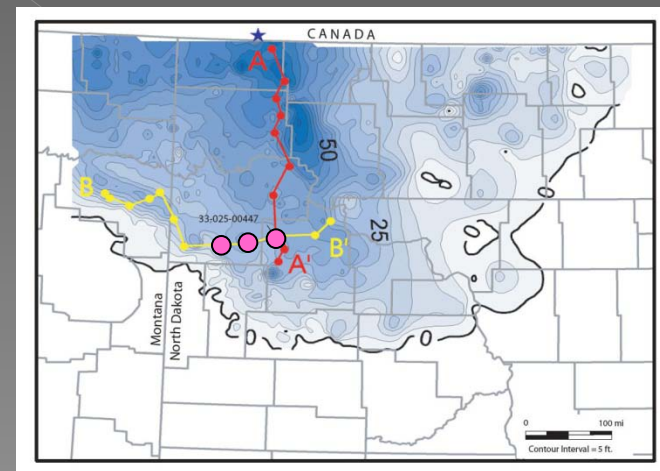
Source: RSEG report: Technology Drives Future Growth; June 15<sup>th</sup>, 2010.





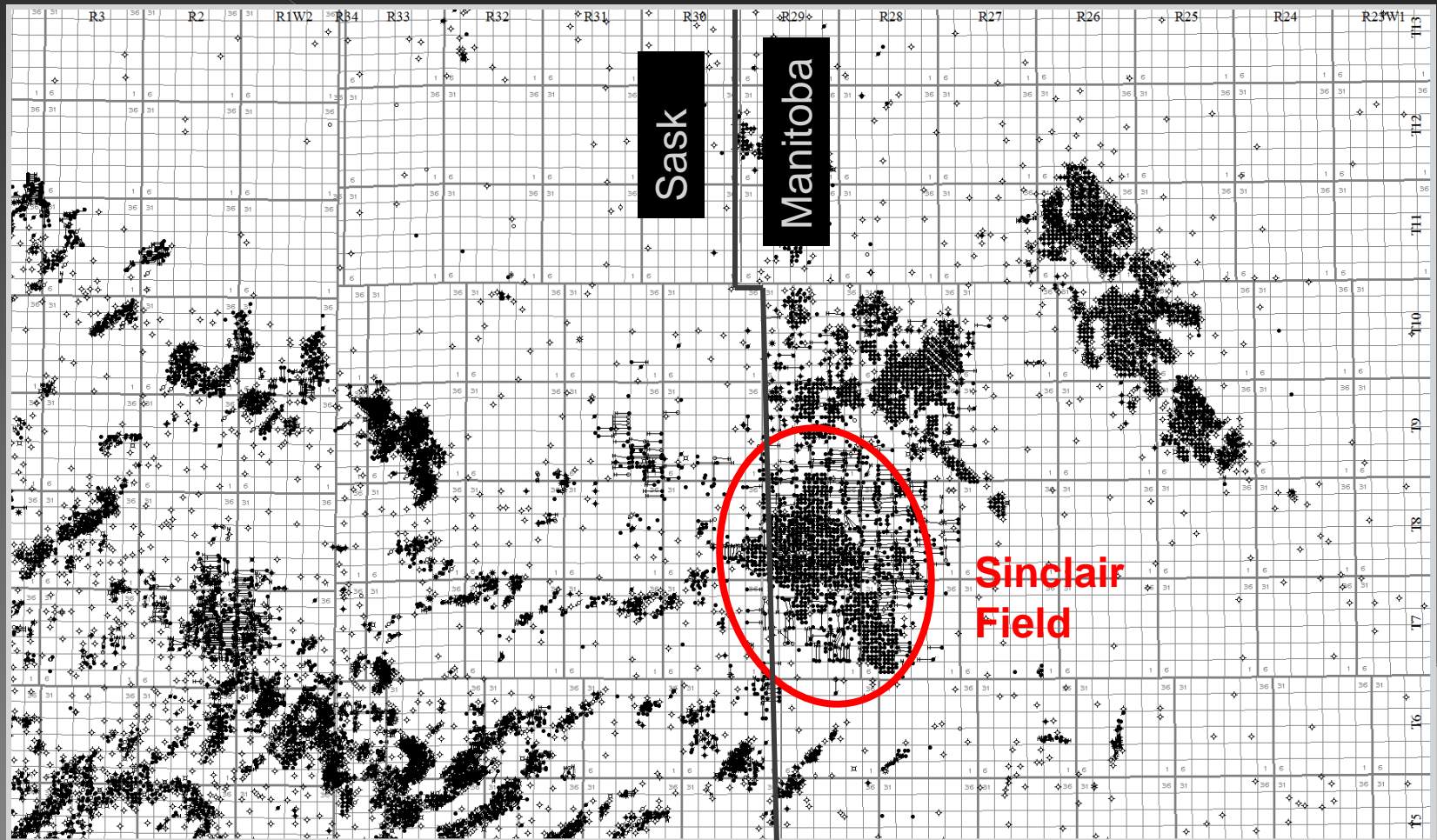
Source: [www.dmr.nd.gov/oilgas](http://www.dmr.nd.gov/oilgas)

Edward C. Murphy (2005), *Geological Investigations #14*



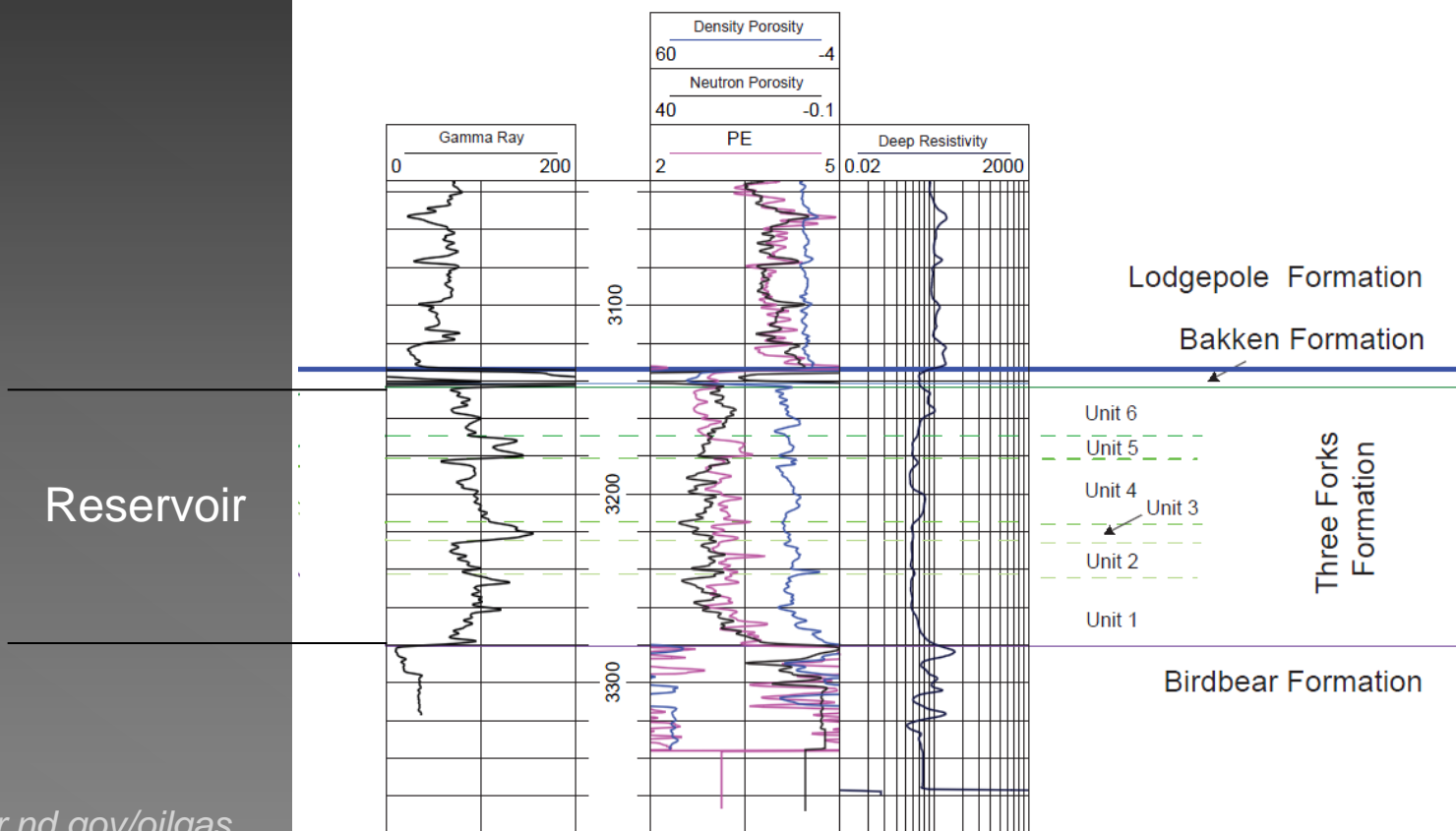
## Examples of Bakken oil downward migration:

### 2) Three Forks/Torquay, Manitoba



100/0991000829W1/00  
5343  
Rideau Petroleum, Ltd.  
Rideau South Ebor 9-10-8-29 WPM  
KB - 1,710 ft.

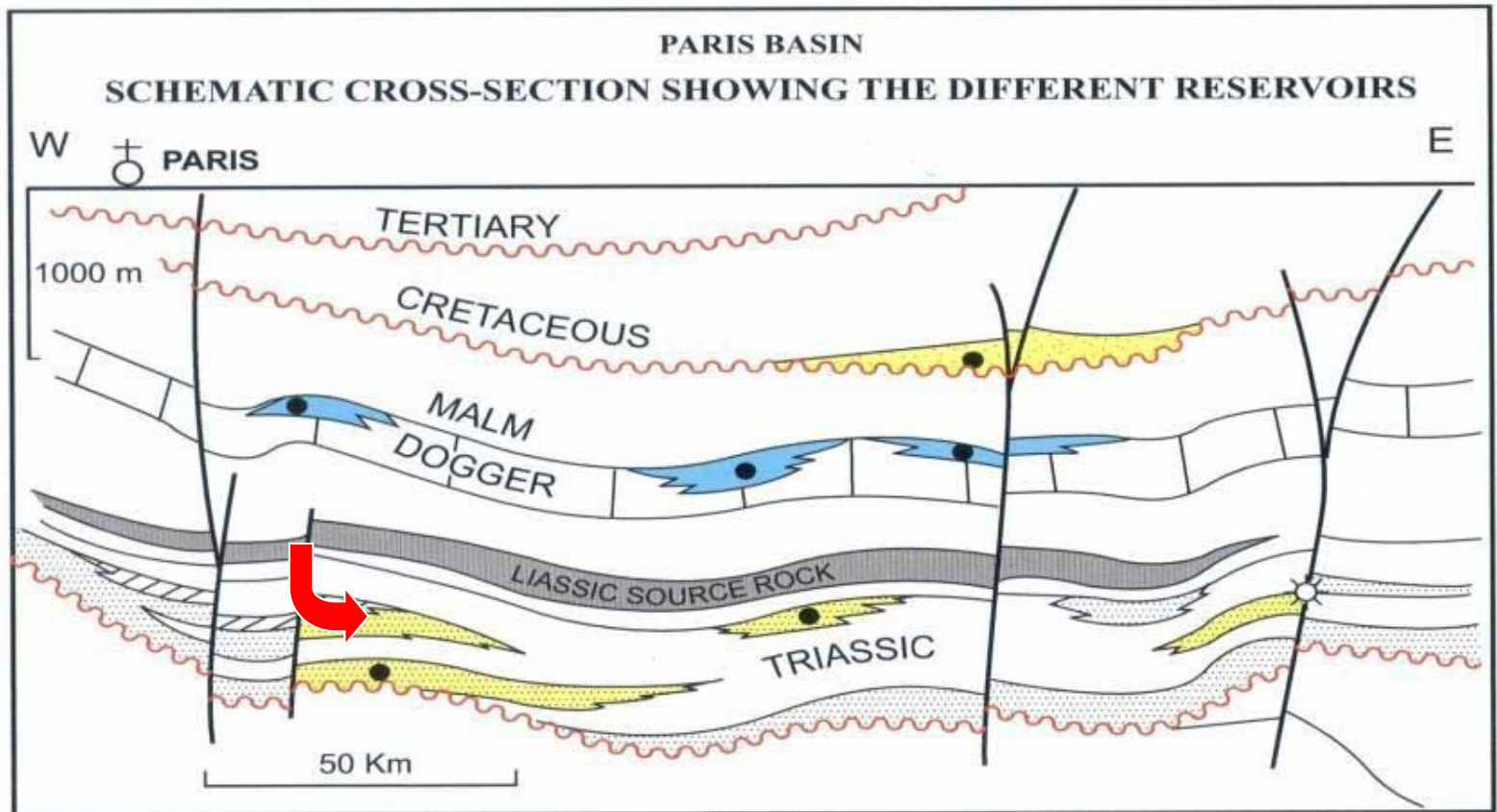
**Sinclair Field, Manitoba**



Source: [www.dmr.nd.gov/oilgas](http://www.dmr.nd.gov/oilgas)

Edward C. Murphy (2009), Geological Investigations #76





(After Bacchiana et al., 1994)

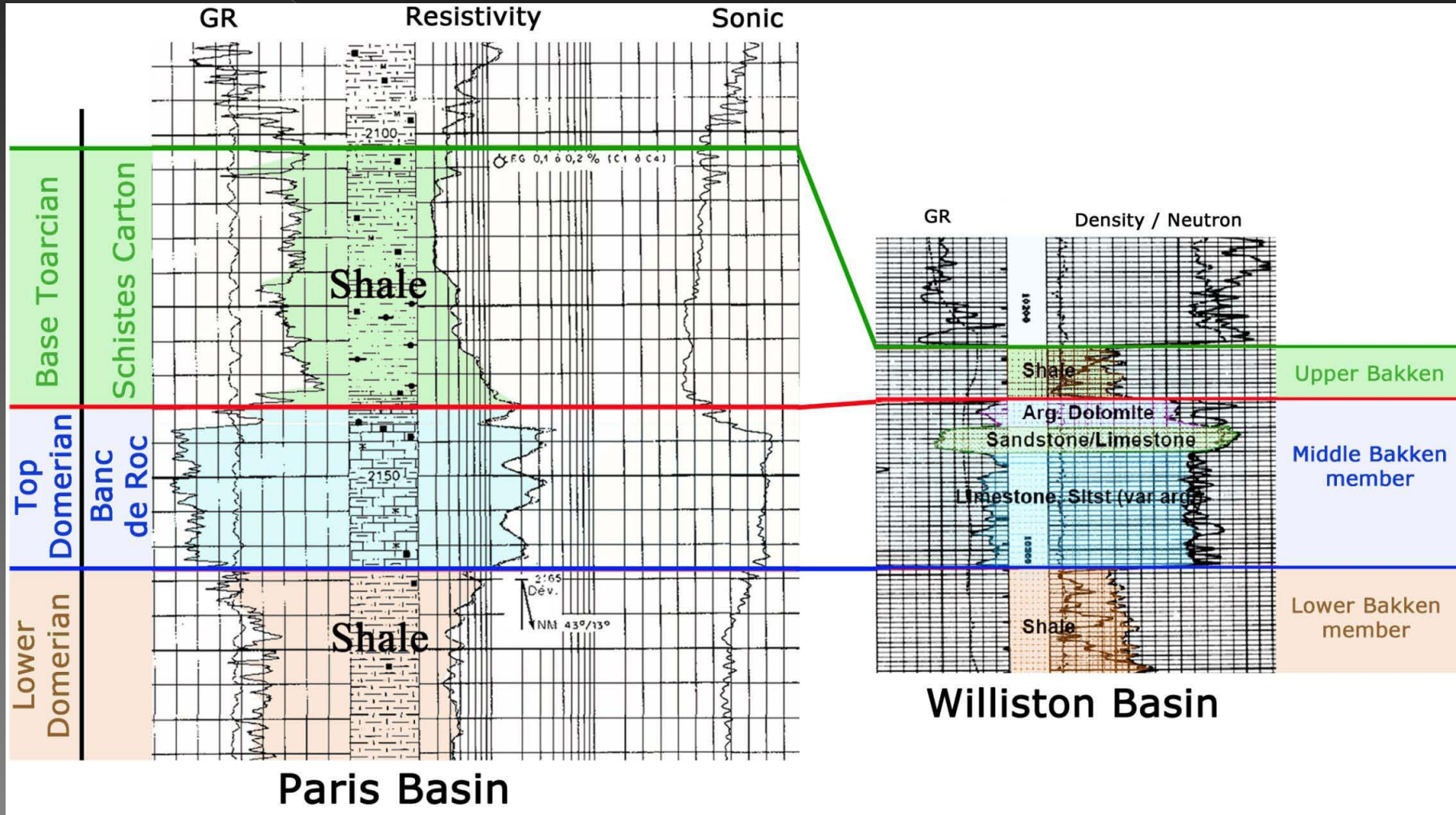
In the present diagram, the red arrow indicates a per descendum migration, via a fault, from the Liassic source rocks to Triassic reservoirs

# The unconventional Sandwich

Bakken  
Schistes Carton

Source rocks  
above and below  
a tight siltstone  
or a carbonate

# The two sandwiches compared



# Comparison in numbers

	PARIS BASIN SHALE OIL	BAKKEN
TOC	0 - 12% (AVG. 5%)	0 - 40% (AVG. 10%)
TMAX	445°C	445°C
SOURCE ROCK	TYPE II	TYPE II
ORGANIC MATTER	MARINE PLANKTON + ANAEROBIC BACTERIA	MARINE PLANKTON + ANAEROBIC BACTERIA
QUARTZ CONTENT	26% - 58%	20% - 68%
DEPOSITIONAL ENVIRONMENT	MARINE AND OXYGEN RESTRICTED	MARINE AND OXYGEN RESTRICTED
COMPETENT LAYER	<i>BANC DE ROC</i>	<i>MIDDLE BAKKEN</i>
NET THICKNESS	1 – 40 METERS (4 - 130 FEET)	2 – 20 METERS (7 – 66 FEET)
POROSITY	UP TO 12%	8 - 12%
PERMEABILITY	UP TO 5MD	0.05 - 0.5 MD
OIL GRAVITY API	38	42

Source: Toreador 2010 presentation



# Conclusions

The Williston and Paris basins are very similar **intracratonic basins**.

The **per descendum migration** mechanism was applied with success, first in the Williston Basin and then in the Paris Basin.

The **enormous success** of the Bakken **unconventional** play should be repeated in the Paris Basin; one company is leading the way.

**Mixing people** with different perspectives or backgrounds can lead to **more innovation** and a faster learning curve.