

Bakken Project

Phase I – Southeastern Saskatchewan

Phase II – North Dakota

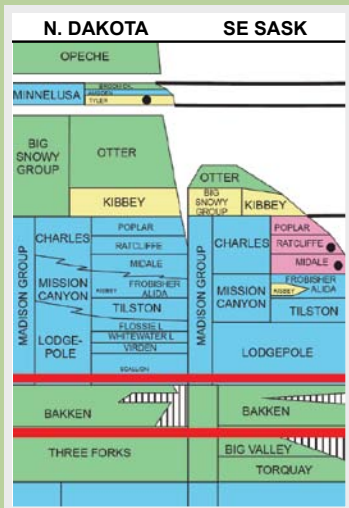
Geology, Hydrogeology and Reservoir Characterization

Unconventional Oil?

The Bakken Formation has fast become the hottest onshore oil play of this decade, revitalizing considerable interest throughout the Williston Basin. Recent activity in Montana, Manitoba and now North Dakota and Southeastern Saskatchewan opens a vast productive fairway. The Middle Bakken siltstones and sandstones are sandwiched between the best known source rocks in the Williston Basin. We recognize three distinct petroleum systems-based play types: overpressured (basin-centered oil), transitional (within mature source rocks) and migrated. The play holds the promise of 3.6 billion barrels of technically recoverable oil south of the border¹ and 1.3 billion barrels in Southeastern Saskatchewan². With substantial variations in facies and reservoir properties, each play type requires its own technological key to to unlock the resources.

¹USGS Estimate ²CDL Estimate

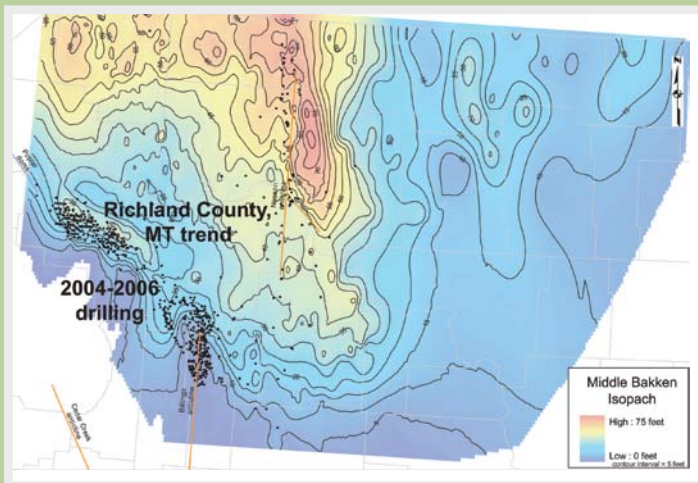
Image above: Excerpt from Bakken horizontal wells initial production oil map



Study Objectives

Canadian Discovery Ltd., Graham Davies Geological Consultants and Rakhit Petroleum Consulting are pleased to announce the first commercially available, integrated multi-client Bakken study. The main components of the project will address geology, reservoir distribution, reservoir petrology/characterization, sedimentology, hydrodynamics and source/migration issues. The project should allow transposition of geologic models and data across borders in order to develop new exploration models and enhance existing ones. Project objectives include:

- ▶ What reservoir characteristics are required for economic production?
- ▶ What roles do sedimentology, diagenesis and pore networks play? (i.e. for frac design)
- ▶ What are the overpressure, transitional and normal pressure boundaries?
- ▶ Are there any effective water bearing zones that can be fraced into or limit the play extent?
- ▶ What is the distribution of the play types?



Phase I – Southeastern Saskatchewan T. 1-16, R. 1-16W2

Although oil has been produced from the Bakken since 1965, production has jumped from 200 bbls/d in 2004 to a current rate of over 30,000 bbls/d and climbing.

Images, clockwise from top: Stratigraphic chart. Coarse and more porous graded laminae. Middle Bakken isopach map (from Flannery, J. and Kraus, J. 2006. Integrated Analysis of the Bakken Petroleum System, U.S. Williston Basin).

Deliverables

Geology

- ▶ Regional and Detailed Stratigraphy (log and core-based cross-sections)
- ▶ Gross and Net Sand Isopach Maps (tied to reservoir characterization)
- ▶ Structure Maps
- ▶ Pool Models and Productivity

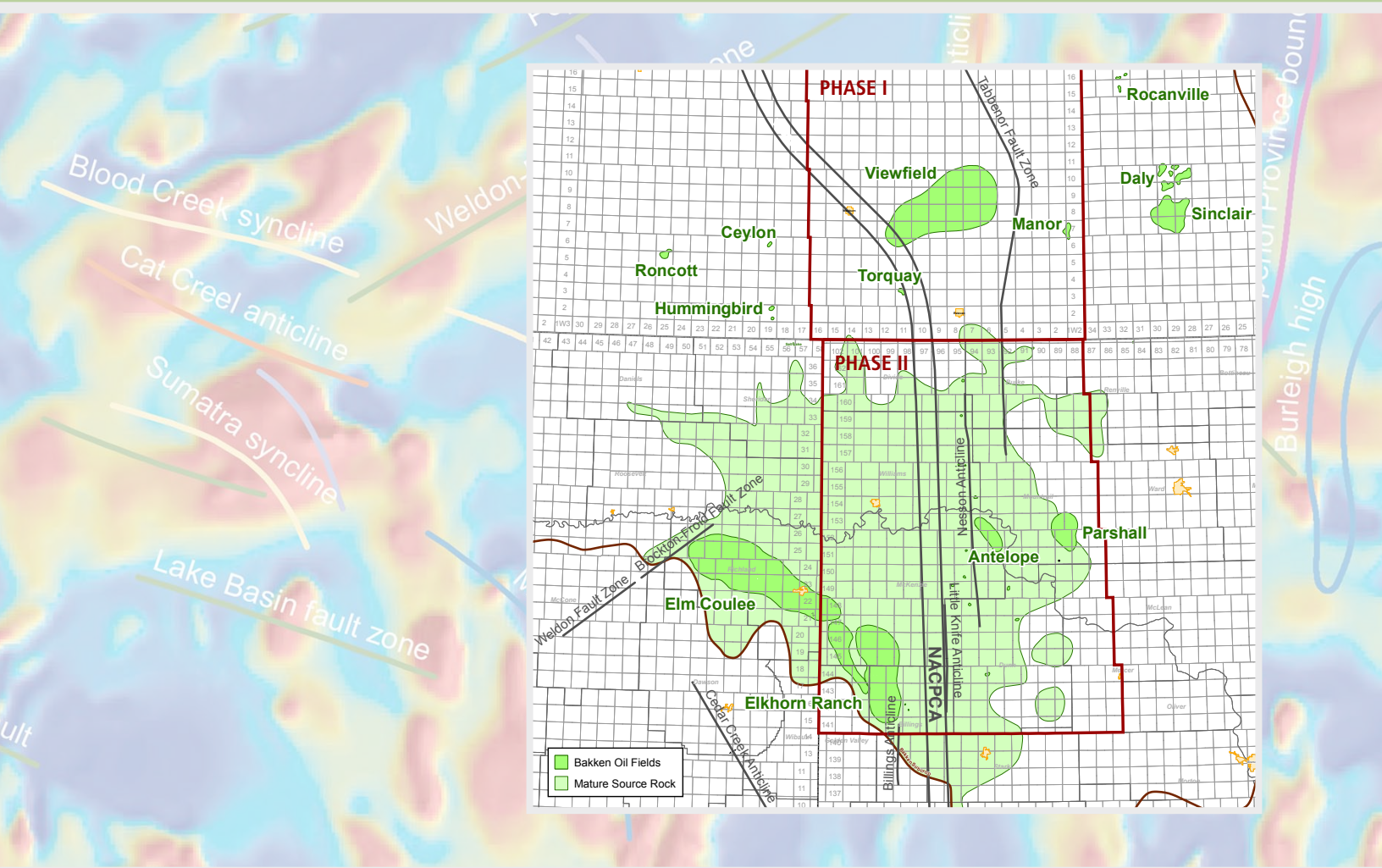
Hydrogeology/Source/Migration

- ▶ Regional Potentiometric Surface Maps
- ▶ Interpreted Pressure versus Elevation Graph
- ▶ Hydraulic Systems Map
- ▶ Source Rock Distribution and Thermal Maturity
- ▶ Petroleum Migration Modelling
- ▶ Water Chemistry (TDS) Maps

Reservoir Characterization

- ▶ Detailed Review of Selected Cores
- ▶ Depositional Models and Facies Distribution (tied to core and log response)
- ▶ Core-based Fracture Density and Orientation*
- ▶ Thin-section Petrography (diagenetic history and pore network)
- ▶ SEM Analysis (minimum 5)
- ▶ Bulk XRD Analysis (minimum 5)
- ▶ Porosity versus Permeability Analysis (from selected cores, where available)

*North Dakota only



Early producers predominantly targeted upper Middle Bakken dolomitic sandstones with relatively 'conventional' reservoir characteristics (12 to 14% porosity, 0.5 to 5 mD permeability). Current development, however, is focussing on bypassed, low resistivity interbedded siltstones of the lower Middle Bakken, with 10 to 12% porosity and 0.05 to 0.5 mD permeability.

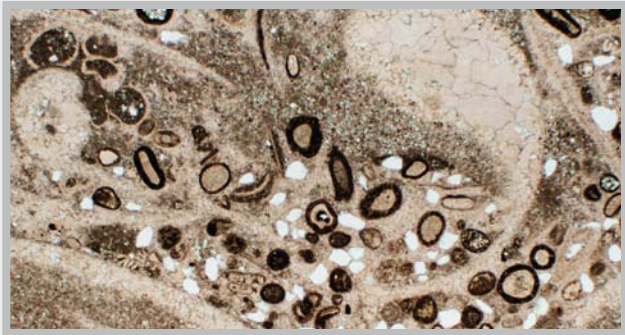
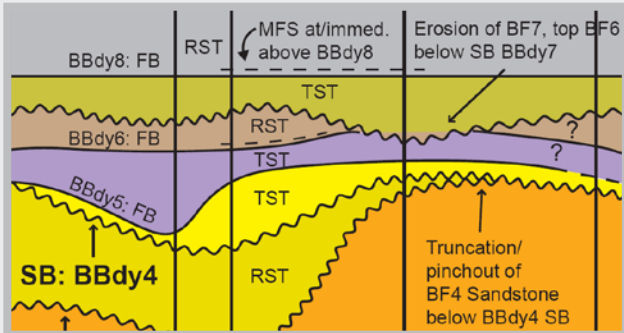
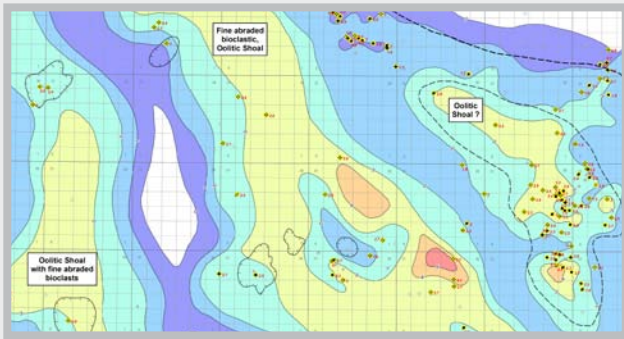
Development of the play is capital intensive, requiring fracture-stimulated horizontal wells with all in costs reaching \$2 million. Reserves and productivity are improving, with EURs ranging from 75 to 150 thousand barrels and IPs ranging from 110 to 225 bbls/d. Due to this wide range in potential productivity, considerable economic uncertainty still exists for the play. The Bakken Formation, much like most unconventional reservoirs is vertically and laterally heterogeneous. Expansion of the play requires an understanding of the variations in stratigraphy, reservoir characteristics, oil charge and petrophysics.

Phase II – North Dakota T. 141-164N, R. 88-105W

The Bakken play in North Dakota started decades ago as a fractured shale play at Elkhorn Ranch and on the Nesson Anticline. The application of fracture-stimulated horizontal well technology in Mountrail County has resulted in the discovery of the Parshall Field with initial well productivity reported to be in excess of 1,000 bbls/d.

At a regional level, North Dakota offers entry into three distinct Middle Bakken plays: Overpressure, Transitional and Migrated. The industry's current focus is within the Overpressure, where a thick, deep Middle Bakken zone has 4 to 8% porosity and 0.001 to 0.1 mD permeability. Southeastern Saskatchewan success certainly suggests the migrated oil play works and has the potential to occur in North Dakota. Expansion of these plays will require an understanding of the variations in stratigraphy, reservoir characteristics, oil charge, petrophysics and hydrodynamics.

Image above, large: Structural elements and crustal boundaries map (from Flannery, J. and Kraus, J. 2006). Above, small: Project study areas.



Images, top to bottom: Excerpt from Bakken facies BF4/BF5 net reservoir map. Excerpt from Bakken sequence stratigraphic summary schematic. Sandy oolitic and bioclastic lime floatstone/grainstone immediately above BBdy7, with convex-up bivalves and small gastropods (originally aragonitic), now preserved as calcite filled molds (micritic lime mud forms geopetal infill).

In partnership with:

RAKHIT
PETROLEUM CONSULTING LTD.

GDGC
GRAHAM DAVIES
GEOLOGICAL
CONSULTANTS LTD.

Phase I Purchase Details

Completed March 2008. Final deliverables include:

- ▶ Comprehensive technical report (80 pages)
- ▶ Technical illustrations (88)
- ▶ Detailed core photos (471) and core descriptions (46)
- ▶ Reference logs (13)
- ▶ Detailed log-core and stratigraphic cross-sections (13)
- ▶ Geothermal gradient, source rock, migration, pool, production hydrodynamics, resistivity, isopach, structure and net reservoir maps (36)
- ▶ Accompanying data and GIS files

Post-Completion: C \$47,500[†]

Phase II Purchase Details

Completed December 2008. Final deliverables include:

- ▶ Comprehensive technical report (100 pages)
- ▶ Technical illustrations (120)
- ▶ Detailed core photos (466) and core descriptions (45)
- ▶ Reference logs (51)
- ▶ Detailed log-core and stratigraphic cross-sections (6)
- ▶ Geothermal gradient, source rock, migration, pool, production, hydrodynamics, isopach, structure and reservoir maps (56)
- ▶ Accompanying data and GIS files

Post-Completion: C \$55,000[†]

[†] plus applicable taxes

Core Workshops Available

Half-day, integrated core workshops with Graham Davies will be conducted on an as-needed basis.

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Bakken Project Update

Geology, Hydrogeology and Reservoir Characterization

Proposed Bakken Update:

New Production, Further Analysis

The Bakken Update will incorporate newly released data to highlight important developments. Project components under consideration include:

- » Refinement of stratigraphic model – additional core and petrology/lab work
- » Additional petrophysical work
- » Updated facies, net reservoir, porosity and water saturation maps
- » Production and completion data analysis
- » Additional hydrogeological analysis
- » Oil-in-place (OIP) resource maps

Purchase Details

Pre-Subscription: C \$15,000[†]

Delivery: TBA

Proposed Bakken Study:

Special Core Analysis

The Proposed Bakken Study will feature special core analysis including:

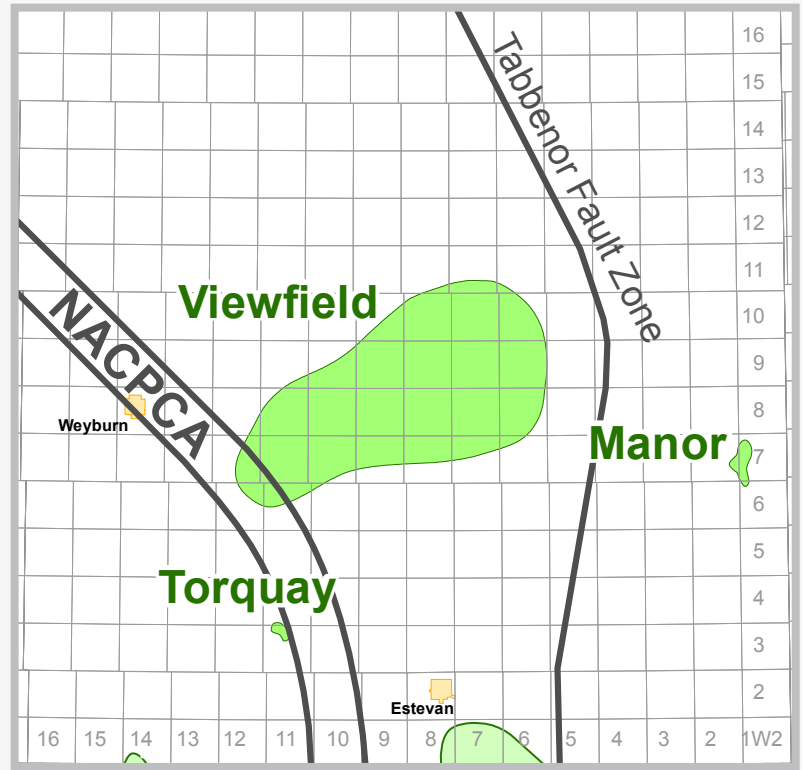
- » Capillary pressure analysis
- » Electrical properties
- » Spectral analysis

Purchase Details

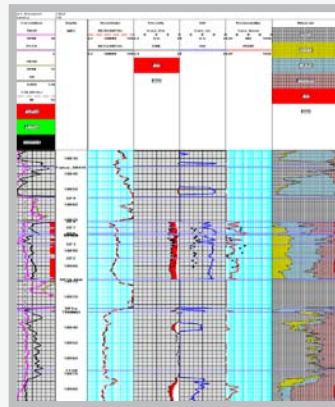
Study: TBA (based on # of participants)

Delivery: TBA

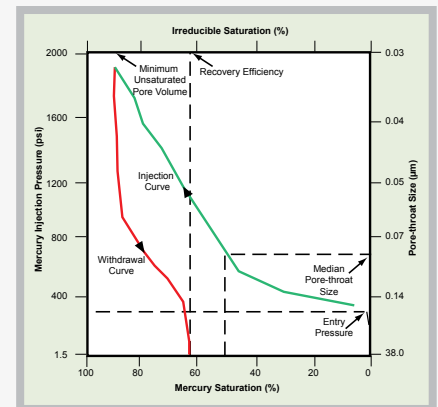
[†] plus applicable taxes



Southeastern Saskatchewan study area: T.1-16, R.1-16W2



Petrophysical answer log
Stohler 21-3H



Schematic capillary pressure diagram, modified
from Jennings, 1987; Varva et al., Netto, 1993

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