Evolution of Oil Production in the Bakken Formation

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North Dakota Geological Survey
Plays of the Bakken Formation

- Conventional Bakken (pre-1987)
  - Cycle 1 – Antelope Structure (1950s – 60s)
  - Cycle 2 – Depositional Edge (1970s – 80s)
- Horizontal Drilling of the Bakken Shale (post-1987)
- Horizontal Drilling of the Bakken Middle Member (2001 to present)
Conventional Bakken
Cycle 1 – Antelope Field

- Discovery Well
  - Stanolind - #1 Woodrow Starr
    - Initial Potential (536 BO; 0.1 BW)

- Antelope Field
  - 52 wells; 12.5 million BO; 10 BCF Gas
  - “Sanish Sand”
  - Completion Method
Conventional Bakken Exploration between Cycles

- Elkhorn Ranch
  - Shell Oil Co. - #41X-5-1 Government

- Nesson Anticline
  - #1 B.E. Hove
    - IP - 756 BOPD, 3 BWPD
    - Completion Method
Conventional Bakken
Cycle 2 – Depositional Limit

- **Stratigraphy & Structure**
  - Thin Bakken
  - Multiple Pays
  - Folds, Faults or Both
  - Completion Methods
Horizontal Drilling of the Upper Bakken Shale

- **Meridian - #33-11 MOI**
  - Drilled vertically
    - Cored, Logged, Drill Stem Tested
  - Drilled Horizontally - 2603 ft
    - 8 ft - upper Bakken Shale
- **IP:** 258 BOPD & 299 MCF gas
- **Cost:** $2 million
Learning Curve

- **Meridian -#33-11 MOI**
  - 57 days to drill
    - 27 days to drill vertical borehole
    - 12 days to drill horizontal section
  - $2 million
- **3 set of 10 wells**
  - 35 days to drill at a cost $1.08 million
- **End of Play**
  - $900,000 (same as a vertical well)
Horizontal Drilling of the Upper Bakken Shale

- Drilling Methods
- General Problems
- Successful well = high volumes of oil
Horizontal Drilling of the Bakken Middle Member

- Richland County, Montana
- North Dakota
Richland County, MT
Stratigraphy

Mississippian Lodgepole Formation

Upper Shale Member

Transitional Facies – L7

Upper (Productive) –– Lithofacies 2

Lower

Transitional Facies - L1

Lower Shale Member

Devonian
Three Forks

Mississippian Bakken Formation

South

North
Balcron Oil - #44-24 Vaira
SESE Sec. 24, T.24N., R.54E.

- Neutron Porosity
- Density Porosity
- GR
- Lodgepole Fm.
  - upper
- Bakken Fm.
  - middle
- Three Forks Fm.
  - Neutron Porosity
SESW Sec. 13, T.23N., R.56E.
AHEL #1 H8 Nevins
Richland County, MT

Bakken/Three Forks Contact
SESW Sec. 13, T.23N., R.56E.

AHEL #1 H8 Nevins

Richland County, MT

Middle Member
Lithofacies 2
Middle Member
Lithofacies 2
(producing facies)

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Richland County, MT
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AHEL #1 H8 Nevins
Richland County, MT

Upper Shale/Middle Mbr
Contact

10582 ft
Formation Limits

Montana | North Dakota

Bakken Formation
- Upper
- Middle
- Lower

Prairie Salt Edge
Isopach of the Upper Member
Bakken Formation

Montana
North Dakota

Contour Interval

32 ft
28
24
20
16
12
8
4
0
Isopach of the Middle Member
Bakken Formation
Bakken Middle Member
Prairie Salt
Richland County

80 Producing Fields
1. Red River Fm
2. Madison Fm
3. Bakken Fm
4. Duperow Fm
5. Interlake Fm

20 Fields produce(d) from the Bakken Formation

08/2004
Historically –
- 42 Bakken wells + 8 commingled wells

Currently –
- 127 Bakken Producers
  - Horizontals – 92 producers, 1 PNA, 1 Dry

Total production
- 2000 – 2,618,982 BO
- 2003 – 5,284,378 BO
- 2004 – 3,275,061 BO (thru August, 2004)

86 Producing Fields, 23 - Bakken Production
Drilling & Completion

Bakken Horizontals

- Two laterals to a 1280 spacing unit
- Well is stimulated with large fracture treatment (~920,000#, gelled water/sand frac)
- Cost $2.2 million
  - 500-700 BOPD initially
  - Virtually no water
Horizontal Drilling of the Bakken Middle Member

- Richland County, Montana
- North Dakota
Lithofacies of the Middle Member

Upper Shale

Lithofacies 5 - Siltstone

Lithofacies 4 – Interbedded Dark Grey Shale and Buff Silty Sandstone

Lithofacies 3 - Sandstone

Lithofacies 2 – Interbedded Dark Grey Shale and Buff Silty Sandstone

Lithofacies 1 - Siltstone

Lower Shale

(From LeFever and others, 1991)
Lithofacies 3
SENW  Sec. 11, T160N, R95W
Conoco, Inc. - #17 Watterud “A”

Producing Zone
Upper L2 Facies
Joilette Oil (USA), LLC.
#1-17R Robert Heuer

- Sadler Field
- Re-entry of a Madison Test (02/13/1981)
- Bakken Completion
  - 03/05/2004
  - IP – 87 BOPD, 150 MCF, 142 BWPD
  - Fracture Stimulated
- Producing Zone – Lithofacies 3
What Do We Know?

- Rocks Types (Montana=North Dakota)
- Additional Productive Section
  - Lithofacies 3, “Sanish”, lower Lodgepole Limestone
- Salt Collapse
- Completion Methods
- High Production Rates
Conclusions

- Horizontal Drilling

Middle Member = Success