



# PROSPECT CENTRE

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## Will new shale oil plays replicate their gaseous cousins?

All shales are not alike, oil shales vary from gas shales—and each other

It won't be all shale gas all the time, if Rocky Mountain oil shales have anything to say about it. They just might with gas prices low and oil prices rising higher. Consequently, drilling rigs are following the money into Rocky Mountain oil shales like the Bakken and, more recently, the Niobrara formation, the Mowry Shale and the Heath Shale in Colorado, Wyoming and Montana.



These oil shales have often undergone partial thermal maturity like their gas shale cousins. But oil shales have seen fewer wells than gas shale plays—and therefore don't garner the same headlines. Like their gaseous cousins, Rocky Mountain oil shales are known as continuous resource plays in which the source rock is often the same as, or close to, the reservoir rock.

### QuickLook

1. **Bakken holds between 3.0 and 4.3 BBO of technically recoverable oil.**
2. **Gas shale manufacturing paradigm won't work in oil shales.**
3. **Companies that learn quickly prosper; those who don't, won't.**
4. **Niobrara may have 227 MMBO, 227 BCFG and 13.6 MMBNGL.**
5. **Rocky Mountain oil shale plays need high prices to work.**
6. **Plays outside the Bakken are too new to predict success.**

One quick caveat: don't confuse the new oil shale plays with oil shale, the greasy, near-surface rock that produces oil only when heated. Rather, these plays produce oil without secondary treat-

### Rocky oil shales need proper stimulation and completion technique

ment. New volumes of roughly 250,000 BOPD from Rocky Mountain oil shales will contribute to the flattening of U.S. oil production, which has been in a steady multi-year decline. Last year, U.S. oil production grew—a rare feat—particularly when considering that the magnitude of increase (7.4%) has not been seen in 40

years (and was once thought impossible with respect to Hubbert's bell-shaped peak oil curve). While most of that increase was tied to success in the deepwater Gulf of Mexico (added ~120 MMBO), oil shale production (added ~18 MMBO) is contributing its fair share, and is forecast to grow at a rate that will keep U.S. production moving sideways for several years.

**Rocky Mountain oil shales differ radically from each other—some aren't even shales.**

It's important to understand the role fracturing plays in oily shales and dolomites compared to gas shales. In both cases, fracturing provides the permeability

needed to produce what is in the formation. But in the Bakken, the oil is held more conventionally in pore space. In gas shales, the gas is held in the shale by absorption and adsorption, which is more of a surface phenomenon. Thus, gas shales need to be fraced, and perhaps refraced, to create new "face" to enable outgassing.

### Persistence shows the way

In 1995 geologist Richard Findley began looking at the middle dolomite layer within the Bakken Shale in eastern Montana, near what would become Elm Coulee field. He convinced Dallas-based **Lycó Energy** to drill 10 vertical wells to test the idea. Out of those wells, seven reached the formation. Though all were sub-economic, they did prove that the modest porosity encountered was oil filled. By early 1999 oil prices had crashed to \$9, and the idea was dead—almost.

As oil prices recovered in 2000, **Halliburton** decided to, in effect, become an LP oil company and bought a stake in the Bakken play. With its expertise in horizontal drilling and fracing, Halliburton wells flowed oil in commercial quantities and a new play was born.

**Continues** On Page 2

## Rounding up the usual suspects

*There is drilling ongoing just below the Bakken in the Three Forks Sanish. IPs there are up 81% sequentially and up 226% year over year. The North Dakota rig count now stands at 105 rigs— more than three times the state's low of 31 rigs in May 2009.*



*Like the gas shale plays, horizontal drilling is essential for success, with operators pursuing longer horizontal sections up to 10,000 feet, and multi-stage fracs, which are now frequently in the 10 to 20 range. The trend towards longer laterals is not so much for operators to save on drilling and completion costs, rather, operators can get more bang for their buck. Recently released results from five Bakken field wells show average IPs of 836 BOEPD. There are now wells that produce double or even triple those rates.*

*Peter Dea, CEO of small privately held **Cirque Resources**, said his company is actively drilling the Bakken, and that before year-end, Cirque intends to drill 7 to 10 exploration wells in the Mowry, Niobrara and Heath Shales. The Heath Shale has caught Cirque's attention "...because of its high TOC of 10 to 20%," explained Dea.*

***MDU Resources Group**, acting through it's wholly owned subsidiary **Fidelity Exploration & Production**, enters the oily Niobrara with a 27,000 net acre position and five-year primary lease terms.*

**Continues** On Page 2

## FEATURED LISTINGS

### MONTANA TROUGH PROSPECT

~97,000-Acres.

FERGUS & JUDITH BASIN. HEATH OIL SHALE

Total Vertical Tested Depth: 1,500-2,500 Ft.

BARNETT SHALE LOOK ALIKE

PLS

Tyler Sand - Large Production Possible.

Shallow Gas Possible & Coals Present.

100% OPERATED WI; 80% NRI

IP's Believed To Be ~500 BOPD.

Est Potential: Multiple Billion Barrels **~87,000**

Shallow, Thick Horizontal Shale Play. **Acres**

Est Drill & Compl Cost: \$1,200,000

DENVER GEOLOGIST CAN PRESENT

**DV 9442**

DV

**New shale oil plays**

Continued From Page 1

It took 18 wells before everything was sufficiently understood to make the play work—and that learning curve continues today. There are still wells that are horizontally drilled, and fraced, which are uneconomic. In total, operators have drilled over 600 wells in the Elm Coulee complex of the Bakken Shale.

Halliburton sold its stake in the play, but the ideas employed spread to other Rocky Mountain oily shale plays, most recently to North Dakota, where the Parshall reservoir is producing 100,000 BOPD. Interestingly, Halliburton has recently again entered the fray, quietly acquiring a small acreage stake in a Bakken play (see sidebar).

**Between the rocks and the hard places**

The Bakken Shale lies mostly in the Williston basin and partially covers North Dakota, Montana and Saskatchewan. In April 2008, USGS reported technically recoverable oil from the Bakken ranged between 3.0 and 4.3 BBO, with a mean of 3.65 BBO. That makes it the largest oil accumulation left in the contiguous U.S., although it

*Oily shales are offering new opportunities for American, Brigham, Cirque, Chesapeake, EOG and many others*

accounts for only about 2.0% of the oil in place. The Bakken formation varies in lithology, but core areas contain three members: the upper shale, a middle silty dolomite and a lower organic-rich silt-

stone. The shale is the source rock and only contributes a minor amount of oil to production, while the middle layer is the primary reservoir, which has low matrix porosity (3 to 9%), and permeability (~0.04 md), and is found at depths of 8,500 to 10,500 ft. Thus, the Bakken Shale should really be called the Bakken Dolomite.

Vertical wells typically have initial production of 100 BOPD or less, while horizontals yield IPs of 200 to 3,000 BOPD but quickly decline. Elm Coulee field and the surrounding area in Montana has been the historic focus of oil production. Oil production peaked at 53,000 BOPD in 2006. It continues to be significant, producing about 40,000 BOPD of high-quality crude. The EUR for the field is more than 200 MMBBLs of oil.

The Niobrara is an oil and gas formation lying primarily in Wyoming and Colorado. People have long known that the Niobrara is an economically productive layer, with production dating back to the late 1800s. Few wells have EURs exceeding 100 MBO, with most less than 50 MBO. Most wells, whether oil or gas, produce little water. Mean USGS estimates of technically recoverable, undiscovered resources for the Niobrara are 227 MMBO, 227 BCFG and 13.6 MMBNGL.

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**Usual suspects**

Cont'd From Pg 1

In the Bakken, the company added 40,000 acres with three to five year terms, bringing its net acreage to 56,000. The deeper Three Forks play is the primary target.

**Brigham Exploration Company** has reported several wells flowing more than 1,500 BOPD. It also fraced one well with long laterals 30 times. The company's #1H State 36-1 flowed 3,807 BOEPD from Middle Bakken in the eastern portion of its Rough Rider project area. The company's April 2010 completion of its Sorenson 29-32 #1H well, located in Mountrail County, N.D., had an early 24-hour peak flowback rate of 3,511 boe/d (2,944 b/d oil and 3.40 MMCFD gas). After removing the frac plugs on the well, it produced at an early 24-hour peak flowback rate of 5,133 boe/d (4,335 b/d oil and 4.79 MMCFD gas). This appears to be a record for any Bakken Shale well.

**In the Bakken, Fidelity added 40,000 acres bringing its net acreage to 56,000.**

**American Oil & Gas** received \$46.2 MM from sale of its Wyoming Powder River basin assets, including its stake in the Fetter and Krejci projects. The company plans to use the money to accelerate the development of the Bakken and Three Forks potential within its Goliath project area.

American's Tong Trust 1-20H well, located in T157N-R96W, Section 20, produced 1,421 boe (1,114 bo and 1.84 MMcf) during an early 24 hour flowback period. The well had a 25-stage frac job and is part of the company's Goliath project. The well was funded by **Halliburton**, who agreed to drill and complete the well plus pay up to \$1.1 million in cash in exchange for about a 7,000 net acre interest in the play. It is located 21 miles from Brigham's State 36-1 well, cited above.

**Chesapeake** is now testing a possible find within Wyoming's Powder River basin. The Spillman Draw Deep Unit State #16-1H, sw-sw 16-35n-73w, is a horizontal Niobrara discovery located within the Spillman Draw Deep Unit, a 25,001-acre unit. The well has a 17,024-foot MD. The discovery is reportedly testing 300-400 BOPD, 350 MCFG and very little water. One mile east of #16-1H, Chesapeake has staked a second horizontal Niobrara test at the Spillman Draw Unit #35-73 15-1H, ne-sw 15-35n-73w. **Cont.** On Pg 4

**Bakken Type Curve Comparison**

Operator	Well Cost (\$MM)	Gross Reserves (MBOE)	Gross F&D (\$/Bbl)	Spacing (Acres)	IP (BOED)	Frac Stages	Lateral Length
Brigham	\$6.3	700	\$9	1,280	2,154	24	9,500
Continental	\$5.4	430	\$13	1,280	761	18	9,500
Encore (Denbury)	\$4.5	350	\$13	-	-	1	-
EOG	-	850	-	640	960	-	-
Marathon	\$5.3	294	\$18	1,280	-	-	-
Questar	\$6.0	550	\$11	1,280	900	-	5,000
Whiting	\$5.0	850	\$6	1,280	2,081	18	-
<b>Average</b>	<b>\$5.4</b>	<b>575</b>	<b>\$12</b>				

Source: Company Reports, Jefferies & Co.



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**BAKKEN****BAKKEN OIL PROSPECT**

PLS

42-Well Potential.

**MONTANA. WILLISTON BASIN**

Bakken Proposed Depths: 7,200-7,500 Ft.

Three Forks Potential Also Identified.

Significant Horizontal Drilling Opportunity.

Additional Shallower Zones Possible

75% OPERATED WI; 75% Lease

Shallower Intervals As BackUp Potential.

Est Bakken Reserves/Well: ~300 MBO

Total Bakken Potential: ~12.6 MMBO

SELLER KEEPING QUARTER OF DEAL

HOU GEOLOGIST CAN SHOW DEAL

DV 2536

**BAKKEN  
OIL****NORTH DAKOTA DRILLING PROJECT**

26-Gross Locations. 19,000-Gross Acres.

**Nesson Anticline**

2,060-Net Acres. ~28% HBP.

Middle Bakken &amp; Three Forks Sanish.

Significant PUD Potential.

Operators: XTO, Continental, &amp; Murex

Est Middle Bakken Rsrvs: ~479 MBOE

Est Three Forks Sanish: ~520 MBOE

Est Drilling Capital: \$5-\$10 MM

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DV 2648

PLS

**BAKKEN  
THREE  
FORKS****SHERIDAN CO., MT PACKAGE**

Multiple Prospects. 97-Potential Wells.

**WILLISTON BASIN**

31,000-Acres.

Obj 1: Bakken. 8,000 Ft.

Obj 2: Three Forks. 8,500 Ft.

100% OPERATED WI; 75% NRI

Est. Well Rsrvs: 500 MBO &amp; 1.0 BCF

Est. Project Rsrvs: 48 MMBO &amp; 100 BCF

DHC: \$3,000,000; Compl: \$5,500,000

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**BAKKEN****HEATH****MONTANA OIL PROSPECT**

PLS

7,900 Acres. 3-Areas. 50-Well Potential.

**HEATH FORMATION****WILLISTON BASIN**

Heath Zone. Target Depth: 4,900-5,200 Ft.

—Similar Tyler Formation In North Dakota.

3-Separate Traps. Thick Sand Intervals.

75% OPERATED WI; 75% Lease

Low Water Saturations.

Est Heath Proved Rsrvs/Well: ~126 MBO

Total Heath Proved Potential: ~6.3 MMBO

Net PV10 (Proved) Value: \$3,944,867

Rsrvs Calculated On 160-Acre Spacing.

Drilling Costs (1-Well): ~\$350,000

CALL PLS TO LEARN MORE

DV 2534

**HEATH  
OIL****New shale oil plays**

Continued From Page 2

The formation has produced for many decades from the fractured Pierre Shale, which lies atop it but is often considered part of the Niobrara formation, as occurs in Florence field near Canon City, Colorado. The Niobrara is also productive at Salt Creek, Teapot Dome, Tow Creek and Rangely fields.

The Niobrara can range from 50 to over 600 feet thick with a 400-foot average and high (up to 5%) organic content. The Niobrara formation is about 7,000 feet deep, located just below the Sussex, Shannon and Pierre Shale formations but above the Codell and J Sand.

The Niobrara Shale is somewhat misnamed, since it contains a high proportion of carbonates, including brittle, calcareous chalk benches, and is often called the Niobrara Chalk, especially toward the east in Nebraska. Natural fracturing can be extensive to the point that fracturing isn't necessary. The highly variable formation can yield oil, gas or both. The Denver-Julesburg basin occupies the most

**North Dakota rig count tripled to 105 units in the last year.**

prospective area of the Niobrara, with the giant Wattenberg gas field (>4 TCFE) near its center. Within the D-J basin, the Niobrara is 200 to 300 feet thick and comprises the Smoky Hill Shale and Fort Hayes Limestone. Besides the D-J basin, Niobrara exploration is ongoing in the southern Powder River basin in Wyoming and in Piceance, North Park, Raton and Sand Wash basins in Colorado.

The Mowry Shale is a hard, black shale that is both source rock and reservoir and is primarily found in Wyoming. Thickness ranges between 100 and 400 feet. According to USGS, cumulative Mowry-sourced production is about 1.2 BBO oil and 2.2 TCF gas. The formation usually produces oil, but can run the full spectrum from mostly oil to mostly gas. Mean estimates of technically recoverable, undiscovered resources for the Mowry are 198 MMBO, 198 BCFG, and 11.9 MMBNGL.

The Heath Shale is the uppermost unit in the Big Snowy Group and lies in the Central Montana Trough in southern Fergus County. The Heath overlies the Madison Group and has vitrinite reflectance values from 0.49–0.55%, indicating that they are thermally immature and are at, or immediately below, the oil generation window.

**Commodity price is king**

Like gas shales, price is king, so today's \$80+ price environment favors oil over \$4 gas. The trend toward incredibly long laterals and high-density fracturing seems to have no end. Given greater variability in the shale resource, targeting sweet spots in the oil-bearing shales will be an even greater challenge than in the gas shales. Eventually, turning more of these oil shale plays into Elm Coulee style successes is possible, but will be difficult. While early results look encouraging, it's simply not known which formations will yield economic production and which ones won't—at least not until it's thoroughly fraced. The Rocky Mountain oil shales are a unique kind of wildcatting. PLS



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rbenoche@plsx.com

## Rounding up the usual suspects

Continued From Page 2

The well has a planned MD of 19,763 feet. TD is expected to terminate about a mile to the northwest. TVD for this hole will be 12,470 feet.

**EOG Resources** has built a position of 400,000 net acres—and plans to acquire more—in a horizontal play for oil and gas in Cretaceous Niobrara fractured shale in the Denver-Julesburg basin. The company is running two rigs and plans to drill several exploration wells this year. EOG has immediate plans to drill three tests—two horizontal and one vertical Niobrara probe—near the Chesapeake discovery. EOG's vertical Niobrara prospect is located roughly a mile southeast of Chesapeake's Spillman Draw Unit #35-73 15-1H. This test, the Lightning Creek #03-23, nw-nw 23-35n-73w, will evaluate the Niobrara at a depth of 12,610 ft. Some 2 miles south, EOG plans to drill the Lightning Creek #1-26H, se-sw 26-35n-73w. This wildcat has a planned 13,547-foot MD, with a TVD of 9,652 feet. The final test staked by EOG is within the Spillman Draw Unit and is some 6 miles east of Chesapeake's indicated horizontal discovery. The Lightning Creek #2-17, se-sw 17-35n-72w, will be drilled to a TVD of 12,480 feet, with a 16,327-foot MD.

The EOG Jake 2-01H, in 1-11n-63w, Weld County, Colo., about 20 miles south of the east edge of Silo field, produced 50 MBO during its first 90 days on production in Q3 2009, EOG said. Its maximum initial rate was 1,558 BOPD and 350 MCFD of gas from a stimulated lateral in the Niobrara. EOG has drilled four other wells in the immediate area. Red Poll 10-16H made 1,100 BOPD unstimulated. Elmer 8-31H had a maximum stimulated rate of 730 BOPD, and Critter Creek 2-03H and 4-09H await completion. The company estimated the cost of a completed well at \$3.4 million and said it continues to test several completion techniques

In the Bakken Shale play in Glacier County, Montana, **Rosetta Resources** found four oil-bearing reservoirs over a 28-mile by 8-mile area, some 400 miles west of the main Bakken fairway. The Tribal Gunsight #31-16H well was fraced and produced oil to test facilities. Tests indicated that only 20% of the stimulation was placed in the right zone.

**Continental Resources** is allocating \$850 million in capital for the Bakken Shale and will drill 218 wells in North Dakota in 2010. The company recently added 71,000 net acres, which brings its Bakken acreage to 652,000 net acres. The company has been targeting the Three Forks, which it believes is a separate reservoir for the Middle Bakken. It plans to drill on 640-acre spacing, but to ultimately cut that distance in half.

It's clear that a number of companies are either permitting, drilling, or have already drilled wells targeting the Niobrara. Besides those mentioned above, others include **Bonanza Creek Energy, Noble, Anadarko, St. Mary, Petroleum Development, Rubicon Oil & Gas, Samson Resources, East Resources, Enerplus, Ballard, Petroleum Exploration & Development and Schneider Energy.** As a testament to the promising nature of the play, **Rosetta Resources** and **Delta Petroleum** have taken up acreage position along the periphery of the play in Yuma and Washington Counties, Colorado.

The new plays should surely stimulate m&a, a&d and joint venture opportunities. **PLS** is marketing 80,000 acres for **Compass Resources** out of Houston which has leased the western flank of the Powder River Basin trend in Wyoming containing natural Niobrara and Mowry shale fractures and additional opportunities in conventional zones. This position lies just to the south of the Teapot Dome Niobrara production and west of the recent Chesapeake activity near Douglas. PLS is also marketing 100,000 plus acres for **Solly Hemus** who has amassed a significant acreage position in Central Montana west of **Endeavor, Rosetta** and **EOG.** And finally PLS is marketing 30,000 acres in East Montana that offers three pay objectives including the Judith River Gas, Heath and Bakken. Interested parties should contact Brian Green as [bgreen@plsx.com](mailto:bgreen@plsx.com). **PLS**

**PLS is marketing >200,000 acres in the Niobrara.**

## NIOBARRA/MOWRY

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32,133-Gross & 17,673-Net Acres.  
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Frontier, Muddy, Dakota/Lakota, Niobrara,  
Horizontal Mowry, Sundance, & Tensleep.  
Structural & Stratigraphic Traps.  
Horizontal Lateral: 4,400 Ft.  
55% OPERATED WI; 44.5% NRI  
Est IP Ranges (Per Obj): 25-100 BOPD  
Total Est Reserves: 2.65 - 35.5 MMBO  
(Higher Estimate Depends On HZ Mowry).  
Long Lease Terms Remaining (70% Fed).  
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DV 2697

GREEN  
RIVER



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