Tight oil in the Rocky Mountains

Executive summary

Tight oil plays in the Rocky Mountains attracted more than US$3 billion in M&A activity in the last quarter of 2010. Operators have rushed to establish a presence in the region after successful development of the Bakken Shale. Consolidation has now begun in the Bakken, where operators have already proven the value of the play.

Development trends suggest that the region will now offer two other sizeable commercial tight oil plays, the Three Forks-Sanish and Niobrara. With further exploration targets remaining, Wood Mackenzie forecasts oil production from the Rocky Mountains to approach one million barrels of oil per day by 2015.

Tight oil driving production growth

Across the Rocky Mountains, operators are looking to repeat the development success of the Bakken Shale. Production growth in the play has now made North Dakota the fourth largest oil producing state in the US.

Within the Bakken, there is an upper, middle, and lower member. Operators primarily target the middle member. Other opportunities have now emerged. Operators have identified the Three Forks-Sanish as a separate reservoir in much of the same area as the Bakken. While operators have traditionally explored the Denver-Julesburg Basin for gas, horizontal drilling and fracing has opened up the Niobrara Shale for oil production. Even though the play is still being appraised, highly publicized well results have driven operators to compete aggressively for acreage in the region.

A number of other tight oil plays in the region are still waiting to be explored. While conventional drilling has targeted the Amsden Formation in Montana, horizontal drilling and fracing could open up development of the underlying Heath Shale, the source rock for most of the Amsden. The shale is more mature in the southeast than the northwest where initial exploration activity could be directed. The shale shows geological characteristics similar to the Bakken. Operators such as Cirque Resources and Voyager Oil and Gas hold acreage positions in the play.

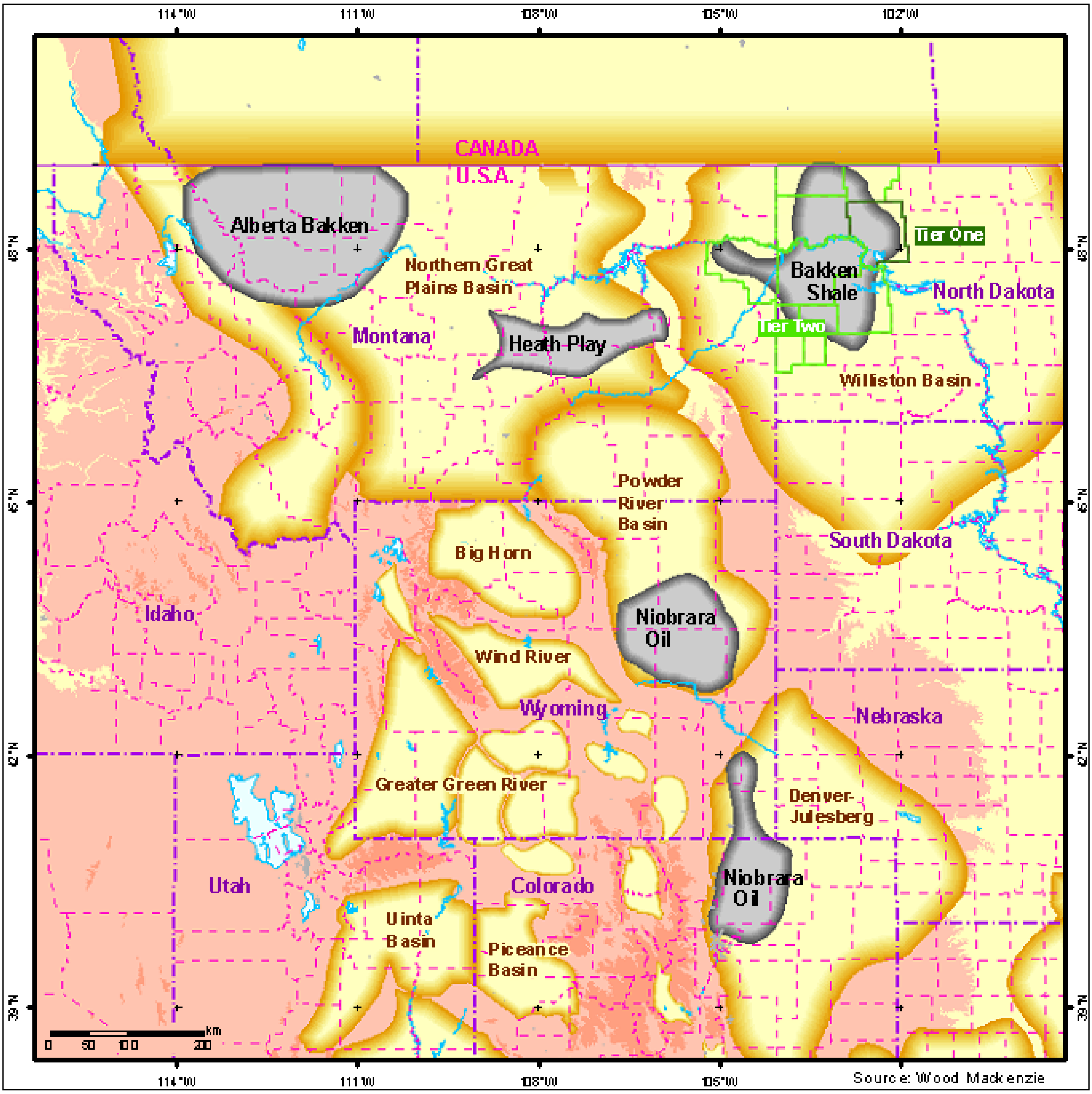
The Alberta Bakken, which lies northwest of Montana, is another play which could benefit from its close proximity to the North Dakota Bakken. The play is approximately 1829 metres (6,000 feet) deep. Although originally targeted for gas, oil is expected to be 42^{O} API, similar to that in the North Dakota Bakken. Active operators include Rosetta Resources, Newfield, and Anschutz. Operators are currently drilling vertical wells to gather more information about the play.

Another tight oil play, the Mowry Shale in the Big Horn Basin is in early stages of development led by Plains Exploration and Resolute. Seismic data is being gathered and test wells have already been drilled.

An active exploration program in these less proven plays depends upon factors such as:

- Resource potential
- Availability of core acreage in the Bakken
- Commercial success of the Niobrara
- Rig availability
- Favourable oil prices to support long term tight oil exploration

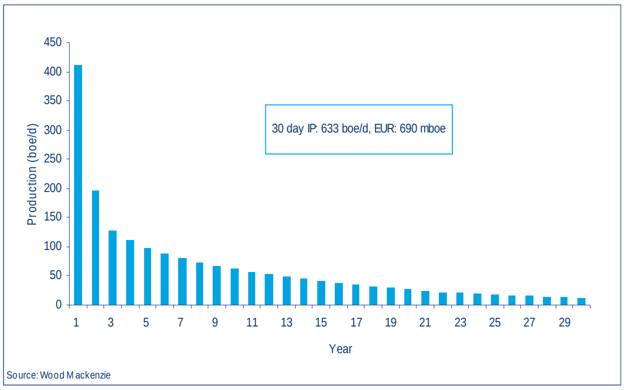
Tight oil plays in the Rocky mountains



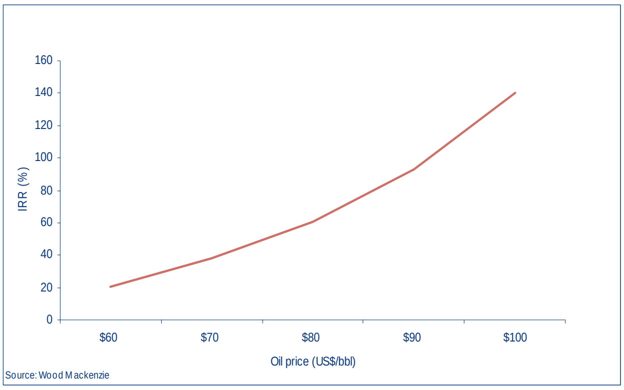
Tight oil leader

The Bakken has been generating positive cash flows for over three years now. Most of the drilling activity takes place in Williams, Mountrail, and McKenzie counties in North Dakota. Cost inflation has been countered by improved well productivity. Originally fractured with fewer than 20 stages, operators are now fracing almost 40 times, with average 30-day initial production rates of over 600 boe/d. This ensures a generous IRR even at US$60/bbl.

Bakken Tier One type curve



Bakken Tier One well IRR

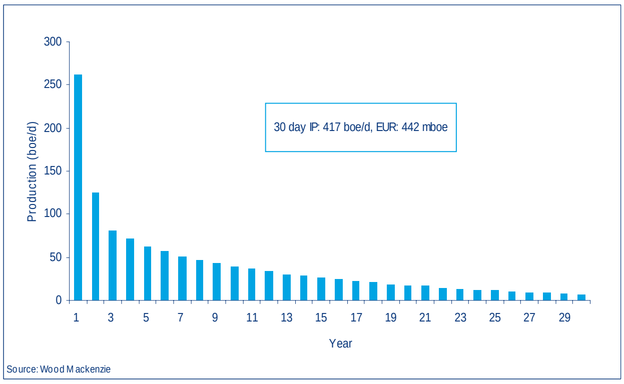


Assumed drilling and completion costs: US$5.5 million

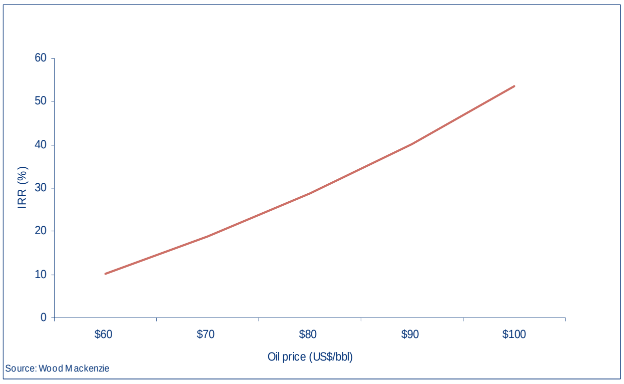
Secondary pay

Operators targeting the Bakken have now started ramping up drilling horizontal wells into the Three Forks-Sanish Formation as well. Hess drills dual lateral wells to produce simultaneously from both formations. Continental Resources plans to drill eight horizontal wells per section targeting either the Bakken or the Three Forks-Sanish. Although returns for the Three Forks-Sanish are not as robust as in the Bakken, they generate a healthy return certain to stimulate sustained investment.

Three Forks-Sanish type curve



Three Forks-Sanish well IRR

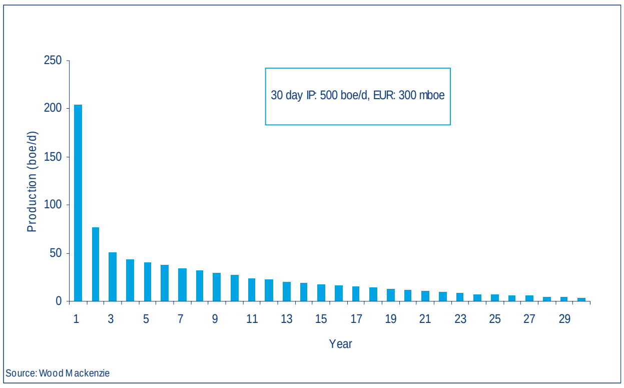


Assumed drilling and completion costs: US$5.7 million

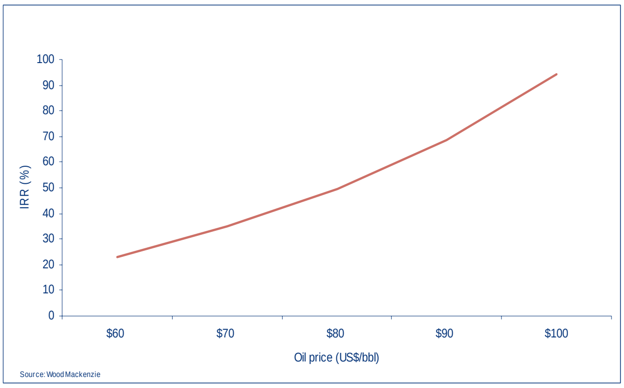
Significant production growth ahead

Following on from EOG's successful exploration of the play, operators are now planning horizontal drilling campaigns targeting the Niobrara in the Denver-Julesburg Basin. Most of the activity is in Platte, Goshen, and Laramie counties in Wyoming and Weld County in Colorado. Operators have also suggested exploring the play in the Powder River and Greater Green River basins. A base case for a horizontal well in the play based on analysis of released well results suggests economics comparing to those in the Bakken.

Niobrara base case type curve



Niobrara base case well IRR



Assumed drilling and completion costs: US$3.5 million

Breakevens

We assume oil from the Bakken and Three Forks-Sanish to be sold at a US$10 discount to the WTI, attributable primarily to transportation costs between the producing fields and the market centres. No such discount is considered for oil production from the Niobrara.

Play	Oil price breakeven (US$)
Niobrara (base case)	38.03
Bakken Tier One	41.50
Three Forks-Sanish	55.10

Source: Wood Mackenzie

Competitive landscape

Proven success and sustained strong oil prices have led to acreage costs in the range of US$3,500 to US$10,000 in the Bakken and Niobrara. Methods of entry include participating in federal and state land auctions and making corporate acquisitions of smaller independents with insufficient capital to develop their vast land holdings.

Acreage positions (top ten operators)

Bakken

Company	Net acreage ('000)
Continental Resources	864
Hess	752
EOG Resources	580
Whiting	552
ExxonMobil	450
Brigham Exploration	368
Marathon Oil	350
Oasis	292
Denbury	275
Newfield	271

Source: Wood Mackenzie

Niobrara

Company	Net acreage ('000)
Noble	830
Chesapeake	800
Anadarko	500
EOG Resources	400
Cirque Resources	250
Fairways	150
Quicksilver	140
PDC	135
Marathon Oil	120
Shell	100

Source: Wood Mackenzie

Mergers and acquisitions

The Bakken has attracted more than US$3 billion in capital in the last quarter of 2010, most of which is attributed to undeveloped positions. Early entrants in the Bakken built strong acreage positions in core producing areas, while late entrants are focussing on building positions in the northern and southern peripheries of the play. No joint ventures in the play have been announced.

Bakken deals since June 2010

Buyer	Seller	Consideration (US$M)	Net acres ('000)
Hess	American Oil and Gas	393	85
Enerplus	Undisclosed	456	47
Kodiak Oil and Gas	Undisclosed	110	15
Williams	Undisclosed	925	86
Hess	TRZ Energy	1,050	167
Occidental	Undisclosed	1,400	180
Total		4,334	579

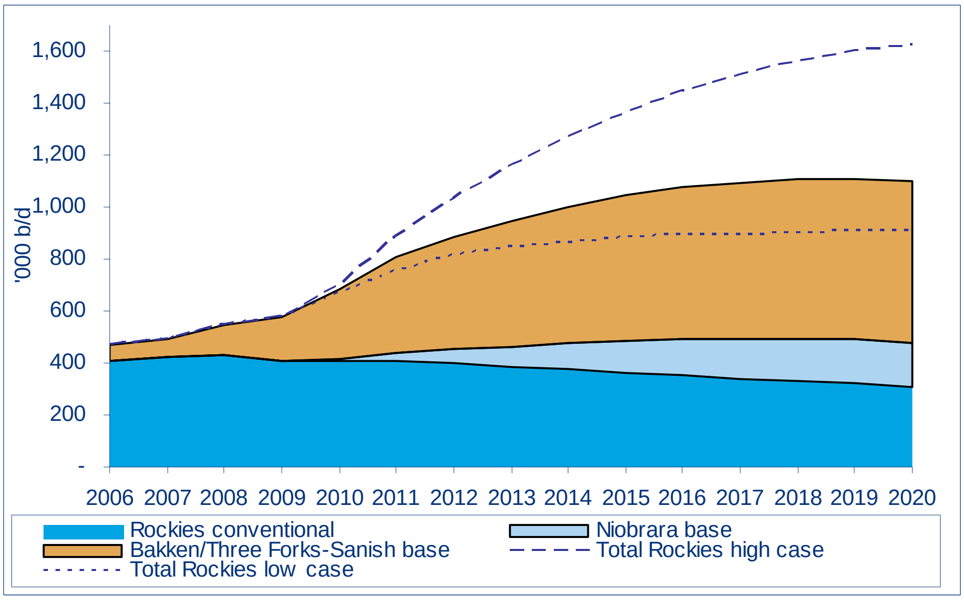
Source: M&A Service, Upstream Research

Operators in the Niobrara have actively built their acreage positions in 2010. Noble entered the region by acquiring assets from Suncor Energy at the beginning of the year. Some operators such as Chesapeake built positions in the Powder River as well as the Denver-Julesburg Basin. On January 30, 2011 Chesapeake announced a joint venture with CNOOC under which CNOOC would purchase 33.3% of the company's 800,000 net leasehold acreage in both the basins with a focus on developing the Niobrara Oil Play.

Supply outlook

More than 170 rigs are currently drilling for oil in the Williston Basin, most of them targeting the Bakken. This level of activity is expected to be sustained and drive production growth through 2016 followed by a production plateau. While it is still early for an accurate assessment of the Niobrara, production could exceed expectations with continued success and further extension of its boundaries.

Rocky Mountains oil production

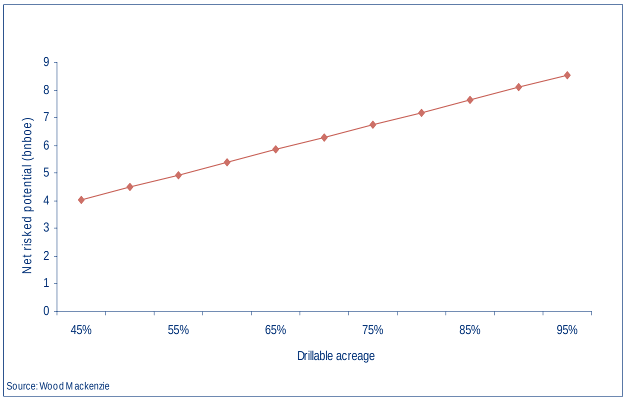


Source: Global Oil Supply Research, Upstream Research

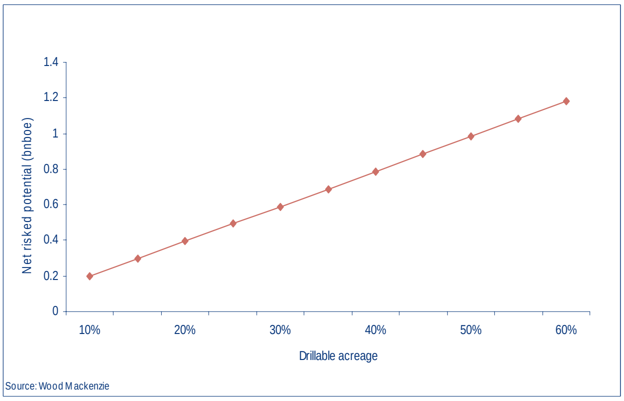
Resource potential

We estimate the commercial resource potential for the Bakken, Three Forks-Sanish, and Niobrara to total 8.6 bnboe. We have assumed the Bakken and Three Forks-Sanish span 7 million acres, with assumed development on 640 acre spacing. We have assumed that the Niobrara spans 2.1 million acres and development will occur on 320 acre spacing. We have risked each according to their maturity.

Bakken and Three Forks-Sanish recoverable reserves



Niobrara recoverable reserves



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