The Niobrara Play
A Geologic Overview

A Presentation to the Public Session
2011 RMS - AAPG
June 26, 2011

Robert Coskey
Rose Exploration, Inc.
The Niobrara Seaway

The World About 90 Million Years Ago

You are here
And seriously
under water!
~300 feet

Niobrara
Chalk, Marl
& Shale

R C Blakey
Niobrara Play – Oil Production

Area of Niobrara Carbonate Deposition (all benches)
Denver Basin – Regional View

Basinal Cross-section

Area of Effective Oil Generation

Denver Basin

Modified from Matuszczak, 1973
The Niobrara Play – Stratigraphy

This Niobrara system has the potential to generate 10~20+ Million Barrels of Oil / Square Mile Depending on Richness and Level of Maturation!!!
The Rock

Hydrocarbon Generation Fractures

Niobrara Core

Microscopic View Natural Fractures

Courtesy Rob Sterling
How ‘Rich’ is the Rock
Organic Richness (TOC)
How Cooked is the Rock
Thermal Maturity

Vitrinite Reflectance* (%Ro) vs Depth

Amoco 344A
sw sw 25-10N-64W

* Vitrinite reflectance is a measure of the thermal maturity of organic material – or how cooked it is…
Thermal Maturity – Mapping

Modified from Matuszczak, 1973

~250 Miles

Silo

Wattenberg

Niobrara Maturity (calc %Ro)

Smagala, et al, 1984
Burial History and Oil Generation

Davis Oil 1 Berry
nw sw 13-16N-66W

Burial History Plot

Niobrara

Generation Potential
210 BO/Ac-ft
150+/- ft shale
~20 MMBO/Sq Mile

Depending on Organic Richness and Maturity!!

Landon, et al, 2001
The Early Niobrara Play – Silo

Silo Field
Disc: 1981
‘Niobrara’ Prod ~10 MM BO

Hybrid Development Process

~1990

St Mary Land 1-19H (2010)
IP: 1,075 BOEPD
Compl: 5/26/2010
Cum: > 100,000 BBL Oil

Stone Energy B-3 (1983)
IP: 37 BOPD
Total Prod: 2,370 BO
Abandoned

Modified from Sonnenberg and Weimer, 1993
The Early Niobrara Play – Structure

Production is Isolated to areas of Structural Deformation

Rangely (CO)

Buck Peak (CO)

Silo (WY)

Vincelette & Foster, 1992
Well Spacing & Surface Issues

South Belridge Field, CA (1911)  Average spacing: One well every 1/2 acre
Evolution of Completion Technology
Why is this working?

Staged Hydraulic Fracturing

Impervious Pierre Shale
> 6000 feet thick

Wellbore & Liner

Hydraulically Induced Fractures

Packers

1 of Multiple Fracks

This process reaches 20,000,000 times more reservoir than old, vertical technology!
Fracture Stimulation Concerns

Why use stage fracks?
- Create more fracture surface area
- Limit vertical growth!

Example Output of a Hydraulic Fracture Model

Horizontal Well

Vertical Well

Main Fresh Water
< 500 feet deep

Surface Protective Casing

Deep Protective Casing

~6000 ft shale above Niobrara blocks vertical propagation of frac

~7000-9000 feet

Niobrara

~4000 feet

~200-400 feet

~4000 feet

Protective Casing
Little America

The Niobrara frac heights are 200-400 feet +/-… Approximately the length of the building we are in!
France To Ban Fracking

“The French Parliament has voted 287-146 to ban hydraulic fracking… a process that activists say is harmful to the environment.”

France24 International News 05/12/2011
Frack Fluid Components

**MOST** of what is pumped is water, which is produced back when the pressure is released.

**Fracking is NOT new...**
First frac was performed in 1947 **in Kansas!**

Volume Perspective

A **small** amount of chemicals are added to the water to perform various functions in the frack job.
Frack References

Excellent, Well Referenced Review of Hydraulic Fracks

FRAC ATTACK:
RISKS, HYPE,
AND FINANCIAL REALITY
OF HYDRAULIC FRACTURING
IN THE SHALE PLAYS
July 8, 2010


Halliburton Discloses Frack Fluid Components


FracFocus Chemical Disclosure Registry

http://fracfocus.org

Slide modified from Coskey, November 2010
Niobrara Acreage Price History

Wyoming & Colorado
Northern DJ Basin Lease Bonus History

Dollars / Acre

Niobrara Effect
EOG Jake well completed 9/5/2009

Courtesy: Pat Jackson
Regional DJ Industry Activity

- RKI Exploration
- Chesapeake / CNOOC
- East Resources (Shell)
- Bill Barrett Corp
- EOG Resources
- Noble Energy
- TARC
- Anadarko – MBI
- Slawson Exploration
- Rubicon O&G… now Chesapeake
- Whiting Petroleum
- SM Energy & Others…

Source: Lewis, R., CSM 2011
## Acreage Holdings by Operator

<table>
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<tr>
<th>Operator</th>
<th>Acreage (square miles)</th>
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<tr>
<td>Noble Energy</td>
<td>750,000</td>
</tr>
<tr>
<td>Encana Corp.</td>
<td>600,000</td>
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<td>Anadarko Petroleum</td>
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<td>PDC Energy</td>
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<td>Carrizo Oil &amp; Gas</td>
<td>58,000</td>
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<td>Rex Energy</td>
<td>39,100</td>
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<tr>
<td>SM Energy</td>
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</tbody>
</table>

~5200 square miles

From Peggy Williams, Hart Energy Publishing 10/2010
Noble Energy – Well Performance

Wattenberg Horizontal Niobrara
Substantial improvement over vertical development

Well Production

Gemini K Well
500,000+ BOE

11 HZ Well Avg
290,000 BOE

Avg Vertical Well
40,000 BOE

Source: Noble Corporate Presentation March 2011
What it Costs to Play the Game

For a 1 well program

- Lease 640 acres at $2,000/acre: $1,280,000
- Drill and complete lateral well: ~$4,000,000
- $5,280,000
- 30 to 50 full-time jobs, touches 40 to 50 companies
- It may take 30+ wells to evaluate a big acreage block
- $158,000,000

• But if it works…? (gross numbers)
  - ~200 BOPD * $85/BBL * 325 days: $5,525,000 / well / yr
  - 30 productive wells: $165,750,000 / 1st yr
Risk to Niobrara Success
What could possibly go wrong?

- **Geologic Risk:** Thermal maturity / matrix porosity
- **Regulatory risk:** no predictability to Fed policy
  - Fracture Stimulation Legislation
  - Environmental Obstructionism: “Impact on Global Climate Change” … **REALLY… Remember the Coccoliths**
- **Availability to infrastructure:** Drilling rigs, water for completion, casing, transport equipment, etc.
- **Takeaway capacity:** Where will the oil go? Pipelines…
- **Rocky Mountain refining capacity:** Where will it be refined?
- **And, the overriding risk…** **Commodity Price…?**
Commodity Price Risk

Week of 6/27/2011

Depending on Cost Structure; Lease Cost, Rigs, Casing, Fracing, etc. Many Horizontal Plays Need >$50-60 Oil

Source: API and EIA data; published in Oil and Gas Journal
The Niobrara Play – It’s not alone

None these plays are on Federal Lands

Bakken / 3 Forks
6-20 Billion BBLs

2\textsuperscript{nd} largest gas field on the planet
Availability of Federal Leases

More than 1,500 parcels/year

New Mexico
Utah
Montana
Colorado
Wyoming

Data provided by Premier Data Services

“2 parcels up for BLM Colorado, oil & gas lease auction” (1609 total acres)
Associated Press 05/12/2011
Cost of Imported Oil!

Week of 6/27/2011

Source: API and EIA data; published in Oil and Gas Journal
The Niobrara Play
Where can it go from here?

- WHAT WE HAVE...
- 10-20+ MMBO Generative Capacity / sq mile
- Large generative area
- Large oil-in-place potential
- Horizontal Drilling
- Staged Fracs
- Ever Improving Technology

- WHAT WE MAY HAVE...
- A Billion Barrel Play?
Nancy Pelosi – Bio-Hybrid Prototype
Thank You!

Rose Exploration