Overview of Selected Shale Plays in New Mexico*

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Abstract

New Mexico, with its multiple productive and frontier basins of different ages, has multiple opportunities for shale plays in strata ranging in age from Early Paleozoic to Late Cretaceous. For this article, emphasis is placed on the emerging Mancos Shale play in the San Juan Basin. Also discussed are productive and potentially productive shale plays in the Permian Basin, the Raton Basin, and a frontier play in the Pedregosa Basin of southwestern New Mexico.

In the San Juan Basin the Mancos Shale (Upper Cretaceous) has been productive from three plays: 1) the basal Niobrara (“Gallup”) offshore marine sandstone bar play in the southwest; 2) the naturally fractured Mancos shales along the southeastern and northwestern flanks of the basin; and 3) “offshore” shales with thinly interbedded sands that occur northeast of the offshore bars. The first two plays are conventional and are mature. The third play is unconventional and consists of marine shales and thinly interbedded sandstones deposited farther offshore (northeast) of the marine bar sandstones. These shales have been produced mostly subeconomically by vertical wells in sparsely drilled reservoirs. The shallower Mancos along the south flank of the basin is within the oil window, and the deeper Mancos in the northern part of the basin is within the thermogenic gas window. With the advent of horizontal drilling and multi-stage hydraulic fracturing this play now has the potential to be economically developed on a large scale. Recent exploratory drilling has been positive.

Several plays are present in the Permian Basin in southeastern New Mexico. The Bone Spring Formation (Permian) has seen extensive development within the Avalon Shale, but horizontal drilling has mostly switched to the Second and Third Bone Spring sandstones as the Avalon has proved gas prone in its western extent. The Bone Spring sandstones have been mostly responsible for the rise in New Mexico oil production from 70 million bbls to 100 million bbls over the last three years. Other possible plays include the Barnett Shale (Upper Mississippian) and the Woodford Shale (Upper Devonian).

The Niobrara Shale of the Raton Basin of north-central New Mexico is an emerging gas play. The Niobrara has been productive from five vertical exploratory wells. The Niobrara is within the thermogenic gas window within the deeper axial part of the Raton Basin and is thermally mature along the shallow eastern flank of the basin, resulting in the possibility of both gas and oil plays.
Southwestern New Mexico has seen multiple stages of tectonic deformation from the Pennsylvanian through the Late Tertiary. The marine Percha Shale (Upper Devonian) is dominated by gas-prone kerogens and is affected structurally and thermal by all tectonic stages. The Percha is within the thermogenic gas window throughout southwestern New Mexico and is metamorphosed where proximal to large intrusive bodies.

References Cited


Broadhead, R.F., (in press), The petroleum geology of New Mexico, in The mineral resources of New Mexico: New Mexico Geological Society and New Mexico Bureau of Geology and Mineral Resources, Special Publication.


Overview of Selected Shale Plays in New Mexico

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RMAG Luncheon Meeting, August 6, 2014
Unconventional oil production made possible by horizontal drilling and multi-stage hydraulic fracturing has revived New Mexico oil production.
We’ll look at the four corners of NM, producing basins in NW, NE, SE:
1) San Juan
2) Raton
3) Permian

And a frontier basin
In the southwest:
4) Pedregosa
San Juan Basin
San Juan Basin geology

From Stone and others (1983)
Gas from Lewis Shale

From Broadhead (in press)
Mancos and “Gallup” reservoirs
Three Mancos and “Gallup” plays

• Older play – “Gallup” marine bar/barrier island sandstone reservoirs along shoreline trend
• Older play – naturally fractured, oil-filled Mancos shales along eastern and western flanks of basin
• New play – “offshore” shales with thin sands with economic potential rendered by horizontal drilling & multi-stage hydraulic fracturing
Mancos and “Gallup” reservoirs by play type
Older “traditional” marine bar reservoir
Lybrook pool

Mesa Petroleum No. 5 South Blanco
25-24N-8W

Gamma ray

Resistivity

Mancos C

IP 55 BOPD + 110 MCFD
New “offshore” horizontal targets
Recent Mancos Shale exploratory wells
Hydrocarbon source rocks

- Mancos shales are organic-rich hydrocarbon source rocks
- Oil window in shallow, southern part of basin
- Thermogenic gas window in deeper northern part of basin
- Maturation influenced by depth and proximity to Tertiary San Juan volcanic field of southern Colorado
Raton Basin
Primary shale gas potential

Modified from Broadhead (2010)
Permian Basin
Bone Spring Formation (Lower Permian)

From Broadhead (in press)
Bone Spring Formation (Lower Permian)

Bone Spring oil reservoirs

Geologic age | Delaware Basin strata | Northwest Shelf strata
--- | --- | ---
Permian | Bone Spring Formation |
Leonardian | |
| 1st carbonate | Glorieta Ss. |
| 1st sand | |
| 2nd carbonate | Yeso Formation |
| 2nd sand | |
| 3rd carbonate | |
| 3rd sand | Abo Formation |
| lower carbonate | |
| "Wolfcamp" (Hueco Fm.) | "Wolfcamp" (Hueco Fm.) |

new Avalon Shale trend
Barnett Shale (Upper Mississippian)

From Broadhead (2007)
After Broadhead and Gillard (2007)
From Broadhead (2007)
From Broadhead (2007)
### Pedregosa Basin

**Deep:**
- **Tertiary:** 500 - 6,000 ft deep
- **Cretaceous:** 800 - 12,500 ft deep

<table>
<thead>
<tr>
<th>Layer</th>
<th>Age</th>
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<tbody>
<tr>
<td>Tertiary</td>
<td>500 - 6,000 ft</td>
<td>clastics, volcanics</td>
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<tr>
<td>Cretaceous</td>
<td>800 - 12,500 ft</td>
<td>Mojado, U-Bar, Hell-to-Finish</td>
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<tr>
<td>Permian</td>
<td>Lower</td>
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<td>Dev.</td>
<td>Percha Shale</td>
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<tr>
<td>Ord.</td>
<td>Montoya, El Paso, Bliss</td>
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<tr>
<td>PC</td>
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</table>
Southwestern New Mexico – Multiple tectonic episodes
Exploration is not for the faint of heart!

From Broadhead (in press)
Percha Shale Organic Richness

From Raatz (2005)
Percha Shale Thermal Maturity

From Raatz (2005)
Summary

• The San Juan Basin has produced low-volume gas from vertical wells in the Upper Cretaceous Lewis and Mancos Shales.
• Current efforts in the San Juan are aimed at pursuing oil from the Mancos Shale on the southern flank of the basin and gas in the northern part. Long-lateral horizontal wells with multi-stage artificial fracturing are essential.
• The Raton Basin has produced modest volumes of gas from the Upper Cretaceous from vertical wells in the Pierre and Niobrara Shales. These are in the thermogenic gas window in the deeper parts of the basin and in the oil window on the shallow basin flanks. Artificially fractured horizontal wells are a must.
Summary (cont’d)

• The Permian Basin has multiple targets for unconventional oil and unconventional gas. At the current forefront are the fine-grained clastics in the Bone Spring Formation. Other shales are intriguing, including the Mississippian Barnett Shale where thermal maturation trends are depth independent.

• There are also possibilities in non-productive frontier basins, including the Pedregosa Basin of southwestern New Mexico. The Devonian Percha Shale is in the gas window.
References


