Midland Basin Wolfcamp Horizontal Development*

Greg Wilson¹

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Abstract

Energen has begun the first phase of a development drilling program in the Wolfcamp Shale in Glasscock County, Texas. This is a discussion of what we have done so far, and where we are going.

References


Website

Midland Basin Wolfcamp Horizontal Development

Greg Wilson

January 14, 2015
What Makes RESOURCE PLAYS Work?

- **Organic Mudstones** (basinal source rocks)
- **Mappable** (significant thickness & areal extent)
- **Richness** (generated oil in place)
- **Repeatable** (predictable results)
What Makes RESOURCE PLAYS Work?

Cont’d

- **Thermal Maturity**
  - Hydrocarbon Generation (Oil / Wet Gas / Dry Gas)
  - Reservoir Quality (porosity & permeability)

- **Petrophysical Properties** (identify, measure, analyze & map)

- **Clay Volume** (low to moderate volume, minimal swelling clays)

- **Rock Mechanical Properties**
  - Drillable
  - Fracable
Permian Basin Stratigraphic Column & Focus Plays

- Bulk of production comes from the Permian sequence
- Major source rocks in the Ordovician, Woodford, Barnett, Cline, Wolfcamp and Leonard
- Historical activity and production has been dominated by shelf carbonate plays
- Shelf carbonates are still being drilled, but activity today is dominated by basin plays
- Industry activity today is focused on the Leonardian, Wolfcampian and Upper Pennsylvanian basin lithology in the Delaware and Midland Basins

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<tr>
<th>AGE</th>
<th>Relative Oil Production</th>
<th>SYSTEM</th>
<th>SERIES</th>
<th>DELAWARE BASIN</th>
<th>NW SHELF</th>
<th>CENTRAL BASIN PLATFORM</th>
<th>MIDLAND BASIN</th>
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**Source Rocks**: Modified from Galloway et al.
Reservoir Quality in a Resource Rock

Intergranular and Intra-Kerogen Ø

Reservoir space is a network of Intergranular and Intra-Kerogen pores molded into a complex geometry.

Porosity determination from Petrophysics requires careful calibration of wireline logs to core measurements, rock mineralogy and clay content.

Permeability is dependent upon the pore sizes and their inter-connectivity.

Reservoir space is filled with a combination of Oil, Gas & Water.

Flow varies with fluid phase, permeability and reservoir pressure.
Thermal Maturity
Hydrocarbon Generation and Reservoir Quality

- **% Ro** (vitrinite reflectance) - industry standard for maturity assessment
  - Microscopic examination from cuttings/core samples
  - Calculated to equivalent % Ro from laboratory data

- **Tmax** (Temp of max hydrocarbon released in analysis)
  - Measured from laboratory analysis
Wolfcamp “A” Core Data
Lavaca 38 #5

Organic Silty Mudstone

- TOC = 2.0 – 4.6% (wt%)
- Ro (calc) = 0.85 – 0.9%
- Tmax = 445-449 (deg C)
- Total Clay = Avg 35% (vol%)
The Petrophysical Model

The Petrophysical Model must be rooted in the rock, fit within the geologic framework, and be vetted against the production.

\[
OOIP = \frac{7758 \times A \times h \times \Phi_e \times (1-S_w)}{B_o}
\]
Midland Basin Exploratory Drilling Program

South Glasscock Wolfcamp A & B Results

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**ERC Daniel SN 10-3 #101H**
- Wolfcamp A
- 8,150’ lateral
- 24 Hour Peak Rate: (3 Phase) 707 BOEPD (89% Oil)
- 20 Day Peak Rate: (3 Phase) 561 BOEPD (86% Oil)

**ERC San Saba NS 37-48 #204H**
- Wolfcamp B
- 7,300’ lateral
- 24 Hour Peak Rate (3 Phase) 1,205 BOEPD (79% Oil)
- *Peak 30 Day Avg: (3 Phase) 870 BOEPD (64% Oil)

**ERC San Saba NS 37-48 #205H**
- Wolfcamp B
- 7,300’ lateral
- 24 Hour Peak Rate (3 Phase) 1,387 BOEPD (80% Oil)
- 20 Day Peak Rate: (3 Phase) 921 BOPED (78%)
- *Peak 30 Day Avg: (3 Phase) 876 BOEPD (75% Oil)

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**ERC Daniel SN 10-3 #102H**
- Wolfcamp A
- 8,150’ lateral
- 24 Hour Peak Rate: (3 Phase) 707 BOEPD (89% Oil)
- 20 Day Peak Rate: (3 Phase) 561 BOEPD (86% Oil)

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**ERC San Saba NS 37-48 #106H**
- Wolfcamp A
- 7,300’ lateral
- 24 Hour Peak Rate: (3 Phase) 1,387 BOEPD (80% Oil)
- 20 Day Peak Rate: (3 Phase) 921 BOPED (78%)
- *Peak 30 Day Avg: (3 Phase) 876 BOEPD (75% Oil)
ERC Development Plan
Pad Drilling

- Minimizes land impacts
- Allows quicker rig moves
- Permits “Zipper” fracing
- More efficient facilities hookup
- Facilitates water recycling

Image source: Laredo Petroleum
Development Pattern
Maximizing the Resource

Fivestones

~7500 ft

1 Mile
Development Pattern

Current inter-well spacing
N to S and S to N crossing wells

Diagram showing well spacing and orientation.
Lateral Targets
S Midland Basin Lateral Schematic

Current ERC Development Program

Additional Potential Hz Targets
Is 250’ vertical separation too close for stacked laterals?
-67% of events in the Guadalupe well occurred within the A interval. If events above the A are ignored, 87% were in the A (vs 13% in the B).

-High-density area of events in the A is 250’ high, almost 1000’ wide.
-68% of events in the San Saba well occurred within the B interval. If events above the A are ignored, 74% were in the B (vs 26% in the A), even with the reduced pressure in the adjacent existing A fracture network.
-Highest density area of events (green rectangle) in the B is 300’ high, almost 1000’ wide.
So do the stacked wells communicate?

During the fracture stimulation: Yes.

But, flowback and production characteristics suggest.....not much.
Spacing: How close is close enough?
Currently about 620’
One way to find out:
Spacing test

Two sets side by side, all parameters (length, stimulation, landing) the same except spacing
Development Pattern: The Next Step
More Pad Drilling
What’s the best arrangement?
How many total horizons?

More to be tested.

Potentially 6+ horizons per pad,
8 pads across a section, 48+ wells per section
It’s going to get crowded out there
(but only on the drilling pads)

Photo from the American Petroleum Institute, via priweb.com
Questions?