Wolfcamp Horizontal Play, Midland Basin, West Texas*

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Abstract

A total of 116,302 wells have been drilled for oil and gas in the Midland Basin of West Texas, including 96,894 oil and gas producers, a success rate of 83%. Productive portions of the Basin are in the south and center of the Basin; the northern portion has had comparatively little production. The Wolfcamp Formation (Wolfcampian-Leonardian) exists across the entire Midland Basin and was first drilled as a vertical oil play in the 1950's. Various operators experimented with horizontal wells in the Wolfcamp during 1990 — 2001, and the results of these early efforts were inconsistent. No wells were drilled in the play until 2007-2010 when six wells were drilled. Activity accelerated in 2011 when 57 wells were drilled in this resource play, and with the success of those wells, interest in the play has increased dramatically. Stratigraphically the Wolfcamp Formation is complex, consisting of mostly shale and argillaceous carbonates, with sand and sandy intervals near the basin edges, and facies that exhibit abrupt lateral changes. The Wolfcamp has stacked pay potential, with six possible target zones in which to direct horizontal wellbores, designated top-down as the A, B, C (upper and lower), and D (upper and lower) zones. The most drilled targets to date are the A and B zones in the section. Depths to the Wolfcamp in the Midland Basin vary from 4,000 feet in the east along the Eastern Shelf to 10,000 feet along the basin axis near the western basin edge. Gross thickness varies from about 700 feet to over 4,000 feet thick, with an average thickness of 1,663 feet. Structure does not appear to be an influence in this play. The total number of horizontal wells in the Midland Basin is 5,114, with 3,017 completed in the Wolfcamp interval. Wolfcamp horizontal wells can exhibit substantial initial potentials. To date, 24 wells have had IP's greater than 2,000 BOPD, with an average IP of all Wolfcamp horizontal wells of 680 BOPD. Although this play is still in the juvenile stage, cumulative production to date is 181 million BO. Porosity of the Wolfcamp Formation varies between 4% and 12% and averages 7%. Permeability is as low as 10 mD, necessitating multistage fracs. The Wolfcamp Shale has excellent shale rock properties; it
fractures well and has a good range of total organic carbon, between 2% and 7%. The Wolfcamp horizontal wells were drilled and completed by 61 operators, with the top three being Pioneer Natural Resources, Apache Corporation, and Laredo Petroleum; 20% of these 61 operators have drilled 80% of the Wolfcamp horizontal wells. Recent drilling has increased lateral lengths to 13,000 feet, with Pioneer leading this effort. Average lateral length for the Wolfcamp horizontal wells is 7,107 feet, and 122 wells have laterals greater than 10,000 feet. Estimated ultimate recovery is greater than 500,000 BOE per horizontal well, which increases with increasing lateral length. Based upon areal extent, thick and abundant source rocks, and multiple producing horizons, the Wolfcamp Play is one of the largest resource plays in the world, particularly when combined with the overlying Spraberry Formation. Total recoverable reserves may exceed 35 billion BOE for the Wolfcamp horizontal play.

References Cited


Pioneer Natural Resources, 2013, Used Slide 30 of 43 from an investor presentation given in 2014. This investor presentation is no longer available through the Pioneer website. It was originally accessed on 1/20/16.

WOLFCAMP HORIZONTAL PLAY, MIDLAND BASIN, WEST TEXAS

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Agenda

- Introduction
- Play History
- Data Summary
- Geologic Characteristics
- Source Rock Characteristics
- Play Particulars
- Summary
- Question & Answer
Play History – Santa Rita No. 1

• 1923 – Drilled and completed. It was one of the first producing oil wells in the Permian Basin. Santa Rita is the patron saint of impossible dreams.

• 1958 - The original production equipment was restored and moved to the Univ Texas Austin campus, corner of San Jacinto Blvd and Trinity Street.

• 1990 - Marathon plugged the well after 67 years of production.
Play History – Santa Rita No. 1

- The Santa Rita No. 1 played a role at the beginning of the 2002 film, “The Rookie”, starring Dennis Quaid.
Midland Basin Summary

- 116,302 Total wells drilled in the Basin
- 96,894 Wells have produced oil & gas
- Success Rate = 83%
- South & Center portions of Basin are the most productive
- 5114 Total Horizontal wells drilled
Data Summary

- Enerdeq – Greater Permian Basin
  571,119 wells
- IHS Interpreted Formation Tops
  284,945 wells
- Wolfcamp Shale Bench Correlations
  6,200 wells
Play Map – Greater Permian Basin

From IHS Enerdeq (2016)
Play History

- 1950-1990 - Vertical play ± Spraberry; 27,114 wells drilled
- 1990-2001 - 12 HZ wells drilled
- 2002-2006 - No HZ wells drilled
- 2007-2010 - 6 HZ wells drilled
- 2011 - 57 HZ wells drilled
- 2012 - 164 HZ wells drilled
- 2013 - 485 HZ wells drilled
- 2014 - 1020 HZ wells drilled
- 2015 - 942 HZ wells drilled
- 2016 - 262 HZ wells drilled (thru May)
Wolfcamp HZ Wells Drilled by Year

Notes
• Data thru August 2016
• Source: IHS Enerdeq (2016)
Geologic Characteristics

- Depths: 4,000 – 10,000 ft
- Thickness: 700-4,000 ft
  > Average thickness: 1,663 ft
- Porosity: 4% - 12%
  > Average porosity: 7%
- Permeability: as low as 10mD
Permian Basin 3D Wolfcamp Structure

Note: Generated from 110,000 Wolfcamp tops; view is to the north. From IHS Formation Tops
Age - Wolfcampian

- Geological Setting
- Late Wolfcampian paleogeography in the Greater Permian Basin

From Fu (2011)
Greater Permian Basin Cross Section
Wolfcampian Paleogeography of the Midland Basin

From Blakey (2008) and Fu (2011)
Regional Stratigraphy

- Stratigraphy of Midland Basin consists of thick Permian & Pennsylvanian sections
- Several productive plays; focus here is on the Wolfcamp
- Wolfcamp has been an active vertical play in the Midland Basin since the 1950’s
- Wolfcamp is now an unconventional play

From Roberts (1989) and IHS Formation Tops
Stratigraphy

- Lithology: Mostly shale and argillaceous carbonates
- Some sand and sandy intervals near basin edges
- Facies exhibit abrupt lateral changes
- 6 shale zones are targets
Midland Basin Sequence Boundaries – Permo Penn

- Sequence boundaries related to transgressive and regressive seas
- 2nd Order Sequence boundaries present during Wolfcampian time

From Fu (2011)
Wolfcamp Shale Benches - Type Log

- Type log for the Wolfcamp Section in the Midland Basin
- Clinton Oil #2 O. L. Greer API# 42-383-10575
- These 7 Wolfcamp Benches correlated in 6,200 wells in Wolfberry Trend in Midland, Glasscock, Reagan and Upton Counties
- Also tied these correlations to over 2,800 HZ wells

Data from IHS Energy (2016) and Baumgardner, et al (2014); Modified Feb 2016
Wolfcamp Structure

- Contoured top of Wolfcamp Fm
- Contour Interval = 500 ft
- Wolfcamp is 1000 - 4000 ft thick
- Tops from GDS correlated tops data (272,000+ correlated wells in Permian Basin)
Wolfcamp Structure

Contour Interval = 25 feet

From IHS Enerdeq (2016)
Cross Section with Wolfcamp Shale Benches
Source Rock Characteristics

- Several thick shales: A, B, C upper, C lower, D upper, and D lower
- TOC: 2% - 7%
- Zones most drilled to date: A and B
- Shales respond well to fracture stimulation
Play Particulars

- 5,114 HZ wells drilled in Midland Basin
- 3,017 HZ wells Wolfcamp;
  - drilled by 61 operators
  - 20% ops drilled 80% of wells
- Top 3 operators are:
  Pioneer Natural Resources
  Apache Corp
  Laredo Petroleum
Play Particulars

- 5,114 total HZ wells drilled in Midland Basin
Play Particulars

• 3,017 total HZ wells drilled in Wolfcamp Formation
Wolfcamp HZ Wells by Operator

Note: Data from Enerdeq thru May 2016
Top 15 Wolfcamp HZ Operators - Midland Basin

- Map of Southern Midland Basin
- The top 15 Wolfcamp HZ Operators have 2,510 wells in the southern Midland Basin
Top 3 Wolfcamp HZ Operators - Midland Basin

- The top 3 Wolfcamp HZ Operators have 1,080 wells in the southern Midland Basin
- These include:
  > Pioneer Natural Resources
  > Apache Corporation
  > Laredo Petroleum
Play Particulars – Lateral Lengths

• Total Wolfcamp HZ = 3,017 wells
• Average Lateral Length = 7,107 ft
• 122 wells with laterals > 10,000 ft
• Laterals now being drilled > 13,000 ft
  • i.e. by Pioneer
Wolfcamp Play

Drilling deeper and adding fracture stimulation stages have added production and improved recoveries.

Horizontal drilling in Spraberry/Wolfcamp further improves recoveries and capital efficiency.

From Pioneer Natural Resources (2013)
Summary

• Based upon areal extent, abundant and thick source rocks, and stacked pay zones, the Wolfcamp Play is one of the largest resource plays in the world.

• When Wolfcamp and the overlying Spraberry Formation are combined, i.e. The Wolfberry Play, this may be the largest resource play in the world.

• Total Recoverable Reserves for the Wolfcamp Play may exceed 35 billion barrels oil.
Questions?