Characterizing and Exploiting the “Clear Fork Shale” near the Midland Basin Margin in Eastern Andrews County, Texas*

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Abstract

We utilized onsite cuttings geochemistry and wireline logs to select rotary sidewall core points in a vertical well to identify possible horizontal targets on an approximately 8000- gross/net-acre block in eastern Andrews County, near the western margin of the Midland Basin. The “Clearfork Shale” was determined to have the best potential for horizontal exploitation in this area. The “Clearfork Shale” is Leonardian age, equivalent to the “Avalon Shale” in the Delaware Basin and the basal San Andres Formation (not the Clearfork Formation) on the Central Basin Platform. Two different intervals, approximately 250 feet apart stratigraphically, have been tested within the Clearfork Shale. The results are encouraging, and more development is planned when crude price recovers.

Selected References


Horizontal Development of the “Clearfork Shale” near the Midland Basin Margin in Eastern Andrews County, Texas

Paul Molnar
January 14, 2015
A Brief History of Diamondback Energy

- First asset acquisition was made in 2006
- In 12/2011, the Company had 54M gross/31M net acres in the Midland Basin, 18 employees and 2,000 BOEPD net production
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- Diamondback IPO’d in 10/2012 at $17.50/share (NASDAQ: FANG)
- Diamondback currently has 105M gross/85M net acres under lease, >100 employees and, as of 4Q14, almost 26 MBOEPD net production
- In 2013, had the largest stock growth within the energy sector; the recent pullback follows the decline in crude price
Asset Assessment and Development

- The majority of existing acreage, and all of the acreage acquired after IPO, is within the “Wolfberry” horizontal play fairway.

- Some of the existing acreage is situated near the basin margin, on the flank of the play’s fairway, where Wolfberry Shale pays are not well developed.

- Other targets needed to be identified.

- The UL “Digger” unit is one such area, and is the subject of this presentation.
University Lands Beekeeper Unit “Digger” Area
Objective: Determine best target zone for horizontal exploitation in Digger

- Large acreage position (~8,000 gross/net acres) with overall disappointing results from vertical program, especially on west side of block (moving onto platform).
- Acreage is laid out ideally for horizontal (N – S laterals, perpendicular to regional P1).
- A vertical test, the UL I 113 was being planned; a data collection program was developed to help identify potential horizontal targets:
  - Weatherford Labs onsite geochem lab
  - Full suite of openhole logs
  - 25 rotary sidewall cores
- Monitor industry activity in the area – other horizontal plays being made?
- Test potential horizontal target intervals in vertical wells, if feasible.
Weatherford Sample Cuttings Geochem Analyses

Entire Sampled Interval
Rotary Sidewall Core Points

RSWC points indicated by red arrows in depth track.
Digger Area Play Assessment

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  - Weatherford Labs onsite geochem lab
  - Full suite of openhole logs
  - 25 rotary sidewall cores
  - Results - The Clearfork Shale has good source quality, is mature, relatively brittle; best horizontal candidate observed in this wellbore. Other candidates include Spraberry, Wolfcamp “A”, “B” and “D” (“Cline”).
- Monitor industry activity – other horizontal plays being made?
  - SM Energy – positive results documented in 2 wells targeting upper Clearfork Shale ~6 miles to the SW (EUR’s ~270 mboe). Digger area ~700’ deeper; more mature, higher pressure, thicker.
- Test potential horizontal target intervals in vertical wells, if feasible.
  - Isolated Clearfork Shale tests in two vertical wells confirmed oil production.
Late Permian (260 Mya) Paleogeography

Source: Blakey, Colorado Plateau Geosystems
Regional Permian Basin Leonardian Stratigraphy

West

Delaware Basin

Central Basin Platform

Midland Basin

East

“Avalon Shale”

1st Bone Spring SS

2nd Bone Spring SS

3rd Bone Spring SS

“Wolfcamp”

“Wolfcampian”

Wolfcampian

“Clearfork Shale”

U. Spraberry

L. Spraberry

Dean

CS Composite sequence

Tidal Flat

LST/TST Siltstone/sandstone

Subtidal Platform

Slope/Basin Mudstone & debris flows

Source: Pollock, 2012 AAPG SW Section, Modified from Ruppel, 2010 BEG
Structure Contour – Top of Lower Clearfork Shale
University Lands Beekeeper Unit “Digger” Area
Clearfork Structural Cross-Section with Petrophysical Analysis

- Clearfork
- Upper Clearfork Shale
- Lower Clearfork Shale
- Spraberry

DIAMONDBACK E&P LLC
UL 113

DIAMONDBACK E&P LLC
UL DIGGER 6-7
Two horizontal CLFK targets were delineated:

1. The lower portion of the U CLFK Shale
   - This interval exhibits excellent source quality, maturation, brittleness and porosity (from geochem, core and log data)
   - Equivalent to interval tested by SM Energy ~6 miles to the SW

2. The upper portion of the L CLFK Shale
   - Better TOC and S1, poorer brittleness
   - Interval tested in vertical recompletions

Geochemical Data Confirms Clearfork Hz Potential at UL Digger Unit
Although the sample from the lower CLFK Shale target interval (#8) is less brittle than the upper CLFK Shale target interval (#6), it still appears to have sufficient brittleness to be a good candidate for frac stimulation.
Rock Eval and TOC for Two Clearfork Target Intervals

<table>
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<th>Depth (Top)</th>
<th>Formation</th>
<th>Sample Type</th>
<th>Sample Prep</th>
<th>*</th>
<th>Leco TOC</th>
<th>RE S1</th>
<th>S2</th>
<th>S3</th>
<th>Tmax (°C)</th>
<th>**</th>
<th>Ro, %</th>
<th>HI</th>
<th>OI</th>
<th>S2/S3</th>
<th>S1/TOC *100</th>
<th>PI</th>
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<td>Plug</td>
<td>NOPR</td>
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<td>18.6</td>
<td>129</td>
<td>0.21</td>
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</tbody>
</table>

Upper Clearfork target has good TOC and S1; Lower Clearfork target is even better.

Brittleness is the only characteristic that is poorer in Lower Clearfork target than Upper Clearfork target.
Cuttings Geochem Diagrams

Kerogen Type (Pseudo Van Krevelen) Diagram - Vector

- UL 1-13: Clearfork
- UL 1-13: L CLFK SH
- UL 1-13: U CLFK SH
- UL 1-13: U SPBY
- UL 1-13: L SPBY
- UL 1-13: WFMP
- UL 1-13: Tippet
- UL 1-13: Mid WFMP
- UL 1-13: Cline

- TYPE I
- TYPE II
- TYPE III
- TYPE IV

Hydrogen Index (mg HC/g TOC) vs Oxygen Index (mg CO2/gTOC)
Cuttings Geochem Diagrams (continued)

Kerogen Conversion And Maturity - Tmax based

- Immature
- Oil Window
- Dry Gas Window

- Intensive Generation
- Expulsion
- Condensate - Wet Gas Zone
- High Level Conversion
- Overmature
- Low Level Conversion

Production Index vs. Maturity (based on Tmax °C)

Data from Weatherford Laboratories
SM Energy Had Been Testing Correlative Interval Nearby

SM UL ‘3’ Callaway 2H Location

SM UL 7 Berkley 4H (aka 10H): IP 46 bopd, 106 mcfgd, 1,001 bwpd

SM UL 30 Cobra 5H: Frac’d 4/11/13

SM UL ‘29’ Sawgrass 5H: IP 136 bopd, 238 mcfgd, 702 bwpd; 1st mo avg. 345 boepd

SM UL ‘29’ Sawgrass 2H: 1st prod 2/13

SM UL ‘36’ Pinnacle 2H: IP 192 bopd, 330 mcfgd, 340 bwpd; 1st mo avg. 288 boepd

SM UL ‘36’ Pinnacle 4H Location
SM Energy cored and tested the Clearfork Shale in a vertical well. In April 2012, they drilled a hz Clearfork well (4,160’ lateral length) that produced 7,629 bo and 7,730 mcfg the first month (avg rate 288 boepd).
Lower Clearfork Zone Had Been Tested 19 Miles to the South

Results were sub-economic

IP 157 bopd
Cum 67 mbo
(Rptd CLFK total)

DST Rec’d
135’ O, 537’ M

IP 162 bopd
EUR 30 mbo
4400’ lateral
UL Digger 601H: Initial Clearfork Shale Test (Upper Shale)

Spud – rig release: 17 days
D&C $7.3MM
Initial Clearfork Shale Horizontal Test (Upper Shale)

- IP: 529 BOPD/492 MCFD (611 BOED)
- Peak 30 Day: 328 BOPD/472 MCFD (406 BOED)
- CUM: 50 MBO/83 MMCFG (64 MBOE)
- EUR: 375 - 400 MBOE

7,541' lateral frac'd with 8.95 MM gals of fluid and 9.1 MM lbs of proppant
UL Digger 502H: Second Clearfork Shale Test (Lower Shale)

Spud – rig release: 15 days
D&C <$7MM
Second Clearfork Shale Horizontal Test  (Lower Shale)

IP: 656 BOPD/261 MCFD  (700 BOED)
Peak 30 Day: 428 BOPD/323 MCFD (481 BOED)
CUM:  40 MBO/44 MMCFG (47 MBOE)
EUR:  450 - 550 MBOE

7,203’ lateral frac’d with 12.4 MM gals of fluid and 8.7 MM lbs of proppant (39% more fluid and 4% less proppant than initial test)
Digger and Nearby Clearfork Horizontal Well Production

- UL DIGGER 502H
- UL DIGGER 601H
- UNIV COBRA 5H
- UNIV Pinnacle 36 2H
- UNIV SAWGRASS 2H
- UNIV SAWGRASS 5H
Conclusions

• There are multiple prospective horizontal shale targets in the Permian Basin, even beyond the traditional “Wolfberry” zones (some may be crude price-sensitive inventory).

• Identify potential candidates:
  • Seek combination of good TOC, maturation, porosity/permeability, brittleness and adequate thickness
  • Look for productive analogs
  • If possible, test in vertical wellbore(s)

• Cuttings geochem is a fast, cost-effective supplement to whole core analysis; onsite analysis can be used in real time in conjunction with openhole wireline logs to select rotary sidewall core points.

• The Permian Basin is a world-class basin with numerous unconventional shale targets within the mature oil window. There’s no better place to hold acreage...
Acknowledgements

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