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The Haynesville Shale Overview

What is it, where is it …

Geology of play

Key components of “sweet” spots …

Progression of the Haynesville Shale Completion Program

What we do…

Identification/Characterization of the XTO Development Process

How we do what we do…

Production practices

Tubing design, facilities, liquid loading…

Proprietary
Unconventional Resources

Haynesville Shale – Let’s get our bearing

Pay Zones

- Rodessa
- James Lime
- Pettet
- Travis Peak (Hosston)
- Cotton Valley Sand
- Bossier
- Haynesville Shale
- Cotton Valley Lime (Haynesville)
- Smackover (Gray)

150’ - 300’ thick
10,500’ - 13,500’ TVD
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Key Geologic Drivers of HVS

- HVS is Organic rich Marine Black Shale
- **TOC**
  - Key Driver
  - Total Organic Carbon = lots of time, lots of heat = Kerogen=oil/gas
  - More TOC moving South in play
- **Calcite**
  - More Calcite, less clay, and more TOC = Pay (Brittle Rock)
  - Higher Porosity (Poro increases w/ TOC)
  - Better Perm (there is perm in shale?)
- **Clay**
  - Less is better. Bossier Shale shows more clay content then HVS
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Haynesville Shale Program Timeline

Avg Daily Gas Prod for Month, MMcfpd

Well Count, To Sales
Well Count, Spud
Rig Count
Study Wells

• Preliminary Completion and Stimulation Design
  – XTO Well #1, Gregg County, July 2008
  – XTO Well #2, Harrison County, August 2008
  – XTO Well #3, Panola County, October 2008
  – XTO Well #4, Panola County, December 2008

• Other (why)
  – Delineation
  – Reservoir Characterization
  – Target Identification
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XTO Well #1, NW Panola County

• **Drilling Program**
  - Existing platform based on CV Lime, James Lime, Pettit, and Barnett Shale Horizontal
  - OBM based on network and industry reconnaissance

• **Casing Design** *(Used existing well design and knowledge gained from CV Lime Horizontal Program)*
  - (7” 32ppf x 4 ½” 13.5ppf P110 Liner)
  - Cemented Liner (No “Packers-Plus”, “Frac-Point”, or other ECP schemes)
  - Premium Connections
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**XTO Well #1, NW Panola County**

- **Completion and Stimulation Design**
  - Average Stimulated Lateral
  - 10-15 Stages
  - Pump Down Plug/Perf/Frac Scheme as opposed to “Packers-Plus” schemes (TCP stage 1)
  - CFPs as opposed to CBPs
  - High rate, large volume slickwater/LGEL frac; experimented w/ slickwater only and hybrid XLGEL
  - 40/80 HydroProp & 100 Mesh
  - Perforation Scheme
    - Longer gun length w/ fewer clusters/stage; Went to shorter gun length w/ more clusters/stage
    - Longer distance b/w perf clusters

- **Completion Execution, Equipment, and Logistics**
  - Completion Procedure
  - 15k Stack Arrangement
  - Flowback Equipment
  - Rig-up for consecutive plug/perf/frac operations
  - Securing water for consecutive plug/perf/frac operations

- **Production Facilities**

- **Other**
  - Securing acreage, forming units
  - Target selection
  - Strategically staking wells, wetlands and culture considerations
  - Securing gas take away, pipeline construction

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Completion and Stimulation Design
- Short Stimulated Lateral
- 10-15 stages (did not drop stages due to less lateral length)
- Charged with task to frac w/ all slickwater
- More clusters per stage; Even less distance b/w perf clusters
  (maintaining same gross interval)
- Attempted slickwater w/ sand/sweep scheme; poor results
- Pumped a lot of H2O volume but little sand
Completion and Stimulation Design
- Long Stimulated Lateral (Longest HVS lateral at the time)
- 15-20 Stages
- Same (more) clusters per stage; Even less distance b/w perf clusters
- Slickwater/LGEL/XLGE Hybrid; good success rate
- Significant amount of sand pumped
- Covered more pay
Completion and Stimulation Design

- Average Stimulated Lateral
- 8-10 Stages
- More clusters per stage; <100’ b/w perf clusters
- Still had charge to accomplish all w/ slickwater:
  - Disciplined rate/pressure management during initial portion of job
  - Significant increase to pad volume
  - Continuous sand (no sand/sweeps)
  - Low sand concentration for extended water volume
  - Use of FR to increase viscosity
Simultaneous Activities

• **Immediate Recognition of Significant Volume of Equipment and Materials Required**
  - Had secured significant volume of high strength proppants directly through supplier (First Mover)
  - Securing significant volumes of freshwater at strategic locations (First Mover)
  - Identifying and building freshwater infrastructure
  - Securing Coiled-Tubing Units
  - Securing Frac Crews

• **Immediate Attention to Cost Reduction and Execution Efficiency**
  - Actually walking through every component of cost
  - Negotiation with every supplier/service provider involved
  - Revising and optimizing completion procedure and process

• **Organizational Structure Changes, Staffing, and Training**
Haynesville Shale Frac Type Curve

Legend:
- Average Type Curve
- Pressure Window
- Point of No Return Line
- Losing Perfs / Perf Fill

Check points:
1. Ball Seat
2. Break down
3. Filling Csg w/ Slickwater
4. Displacement of all FW w/ SW
5. Design Rate Pressure Peak
6. Minimum Pressure
7. Point of No Return

Pressure (psi) vs. Time (minutes)

Key pressures:
- 0.25 ppa 100 mesh
- 0.25-.45 ppa Sand
- 0.45-.75 ppa Sand
- 0.75-1.25 ppa Sand

Time (minutes): 0 60 120 180 240 300 360
Pressure (psi): 5500 6000 6500 7000 7500 8000 8500 9000 9500 10000 10500
Haynesville Shale Frac Type Curve - Early Time

Check points:
1. Ball Seat
2. Break down
3. Filling Csg w/ Slickwater
4. Displacement of all FW w/ SW
5. Design Rate Pressure Peak

Legend:
- Average Type Curve
- Pressure Window
- Slurry Rate Trend
- 5 bpm increments as pressure allows
- 5-8 bpm increments as pressure allows
- Design Rate
- Slicking up pipe

5500 6000 6500 7000 7500 8000 8500 9000 9500 10000 10500
0 15 30 45 60 75

Time (minutes)
Pressure (psi)
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Completion Summary/Cost Efficiency

- **Cover the most rock possible**
  - Contact the most pay

- **Perf clusters/stage, distance b/w clusters,**
  - Determine rate/perf cluster desired
  - Space stage length for most rate per perf cluster
  - More rock stimulated better results
  - Decrease spacing b/w clusters

- **Proppant**
  - How much proppant per perf cluster/stage
  - Do we need high strength large proppant??
  - Is sand or rate more important

- **Fluid**
  - More volume or more sand
  - Costs associated to pumping gels

- **Time is money**
  - More fracs/day saves money
  - Spending a little more money per stage saves overall job costs i.e. shorter fracs more proppant placed in given frac time
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A Running Machine

- Repeatable Drilling Program and Casing Design

- Repeatable Completion and Stimulation Design
  - Repeatable procedure
  - Well prep standardization
  - Standardized rig-up
  - Repeatable frac design and plug/perf/frac proc
  - Drill-out procedure
  - Flowback guidelines
  - Production facilities
  - Tube up equipment and guidelines

- Materials and Equipment Identified, Secured and/or in Process

- Organizational Structure and Staffing
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Haynesville Shale Program Timeline

- Spud 1st HZ, #1H Sept 08
- 1st Pilot, HZ #3H, June 08
- 2nd Pilot, HZ #2H, Aug 08

< 9 months

Avg Daily Gas Prod for Month, MMcfpd
Well Count & Rig Count

- Well Count, To Sales
- Well Count, Spud
- Rig Count

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XTO Haynesville Shale Completion Process

- Completion Preparation
- Consecutive Stage Work
- Drill-out and Flowback
- Tube-Up
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Completion Preparation

Drilling Rig Move, Location Dress and Layout → MIRU WOR, NU BOPs → PU Workstring, Make Bit/Scraper Run → Polish TOL → RUN USIT; Pressure Test

RU Frac Stack and Flowback Equipment → MIRU CTU, Mill/Motor/Mr. Clean, Pressure Test → TCP; Pressure Up on Formation → Waiting on Frac Equipment
Consecutive Stage Work

- Seat ball/break down
- Begin AM frac
- Pumpdown Tools
- Set Plug/Perf
- Drop CFP ball
- Begin PM frac
- Pumpdown Tools
- Seat ball/break down

4 Stages Per Day (24hrs)
Some details on today’s completions

- 2’ gun length, 6 SPF, 60 Deg
- 4-6 clusters per stage, moving to 5-7 clusters as heel is approached
- 50-100’ b/w clusters
- 250,000 to 300,000 lbs proppant/stg.
- 8,000 to 10,000 lbs 100 mesh
- 12,000 to 15,000 bbls Slickwater and or Linear Gel depending on geology
- High rate (70-100+ BPM)
Drillout, Flowback, and Tube-Up

• **Drill-out and Flowback**
  - Restricted flow flowback. Choke size determined on well’s pressure. Maintain good flowing pressure. Do not open to “world”.
  - Drillout w/ 2” CT
  - “Reverse Drag” mill
  - 2 Plugs then short trip to circulate cuttings
  - 10 Plugs per mill
  - Close attention to maintaining bbl in – bbl out
  - Disciplined and patient flowback (maintain pressure)

• **Tube-Up**
  - Tube-up within 90-120 days
  - Lubricate and set permanent packer with profile plug in place
  - Run tubing, SL retrieve plug
**Production practices**

- **Wells make little fluid**
  - Industry has showed several different methods of de-watering HVS wells
  - Pumping unit assist
  - Capillary siphon strings to help alleviate corrosion/scaling tendencies

- **Wells are sweet until we mess with them**
  - Some wells are showing high levels of H2S
    - In-situ or frac induced?
  - High H2S wells are using scavenger or amine towers to drop to pipeline specs
  - CO2 is low in XTO areas, however, some areas have reported 15% + CO2 concentration

- **Time will tell how to optimize best practices for producing HVS wells**
Always Refining

- Tweaking procedure details
- CFP mill-out procedure and equipment
- Perforation scheme and frac sensitivities
- Adapting fracs to changing cost structure
- The infamous “Toe Frac”
- Multi-Well pad considerations
- Offset operations consideration
- Other operational issues... “What to do if” Scenarios
  - Unsuccessful Pressure Test
  - Zone won’t take sand
  - Screen-out
  - Other
Characterization of the XTO Process

Proprietary

You gotta break eggs to make mayonnaise.”
– Kevin Brand, Production Superintendent, East Texas Division

“If it doesn’t work, it sure missed a good chance.”
– Bo Sanders, Production Superintendent, East Texas Division

“You have ‘working managers’…”
– Ken Kirby, Senior V.P., East Texas Division

“We do our research from outside the wellbore.”
– Keith Underwood, Engineering Manager, East Texas Division

Unconventional Resources

Optimization

Rapid Deployment of Working Model
(Manufacturing Phase)

Preliminary Design
(Adjusting the Conceptual Design based on empirical data to arrive at a “Working Model”)

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Questions?