2011 AADE Operators Symposium

Chesapeake Energy
Anadarko – Granite Wash Improvements

Craig Staley, Drilling Engineer – Anadarko Basin
Colony Wash – Overview
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● Highlights

- 1st Spud November 2006
- 9 Rig Program
- 118 Wells
  - 43 in 2010
    - 12,500’ TVD 16,900’ MD
    - 48 Days - $3.96MM
Colony Wash – Overview

Colony Wash Rig Count

<table>
<thead>
<tr>
<th>Year</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
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<tr>
<td>2007</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>2008</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
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<tr>
<td>2009</td>
<td>8</td>
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<td>11</td>
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<tr>
<td>2010</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
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Colony Wash – Well Design

- 4th Edition
  - 9 5/8” Surface 1,500’
  - 7” Inter. 12,000’
  - 4 1/2” Prod. 16,900’
Colony Wash – Surface Hole

- Spud to Drill Out Float Equipment
- Surface Casing Waiver to OCC (BTW 300’ – 500’)
- 12 1/4” hole to 1,500’
- Drill with 117 IADC roller cone bit

<table>
<thead>
<tr>
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<th>2010</th>
<th>Delta</th>
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<tbody>
<tr>
<td>Overall Time, avg hrs</td>
<td>52</td>
<td>6.5</td>
</tr>
<tr>
<td>Drilling Time, avg hrs</td>
<td>14.5</td>
<td>1.6</td>
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<tr>
<td>Technical Limit, hrs</td>
<td>29.5</td>
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- 2011 Improvements: Rig to Rig Consistency
**Colony Wash – Intermediate Hole**

- Drill Out Surface to FIT
- Drill Out 8 3/4” to depth of 100’ above KOP (12,000’)

<table>
<thead>
<tr>
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<th>Avg Ftg 2010</th>
<th>Avg Ftg Prior</th>
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<td>Drill-Out</td>
<td>6173</td>
<td>6140</td>
<td><strong>33</strong></td>
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<td>Follow Up</td>
<td>1927</td>
<td>2390</td>
<td><strong>463</strong></td>
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<td>Bottom</td>
<td>1100</td>
<td>646</td>
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<table>
<thead>
<tr>
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<th>Avg ROP 2010</th>
<th>Avg ROP Prior</th>
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<td>Drill-Out</td>
<td>94.7</td>
<td>79.1</td>
<td><strong>15.6</strong></td>
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<tr>
<td>Follow Up</td>
<td>47.1</td>
<td>35.9</td>
<td><strong>11.2</strong></td>
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<td>Bottom</td>
<td>38.0</td>
<td>11.4</td>
<td><strong>26.6</strong></td>
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Colony Wash – Intermediate Hole (Cont.)
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<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>Delta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Time, avg hrs</td>
<td>300</td>
<td>40</td>
</tr>
<tr>
<td>Drilling Time, avg hrs</td>
<td>172</td>
<td>47</td>
</tr>
<tr>
<td>Technical Limit, avg hrs</td>
<td>246.5</td>
<td>28</td>
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- **2011 Improvements**: Continued bit development
Colony Wash – Pilot Hole

- FIT to PU Directional Tools

- 60% have Pilot holes

- Drill 6 1/8” Hole (12,000’ – 13,500’)

- PDC Drillable
  - 2.5% 1 bit  60% 2 bits  22.5% 3 bits  15% 4 bits or more

- MW 11.5 ppg – 12.5 ppg OBM
  - Have done WBM for cores (Geology)
Colony Wash – Pilot Hole (Cont.)

- 2010 Average footage in Pilot Hole = 1030’ (174’)

- Set open hole whipstock
  - STC Track Master Plus w/ Expandable Anchor
    - Mill 2’ - 4’ TOOH for tools

<table>
<thead>
<tr>
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<th>Delta</th>
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</thead>
<tbody>
<tr>
<td>Overall Time, avg hrs</td>
<td>130</td>
<td>16</td>
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<tr>
<td>Drilling Time, avg hrs</td>
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<tr>
<td>Technical Limit, hrs</td>
<td>61.5</td>
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- Improvements in 2011: Hybrid Impreg/PDC bit
Colony Wash – Curve

- PU Tools to Landing Point
- Drill 6 1/8” Hole
- History
  - Build with insert, finish with PDC
    - 2 Bit Interval = 38%
    - 3 Bit Interval = 32%
    - 4 Bits+ Interval = 30%
- Drilling Statistics
  - 78% Slide Drilling
    - Sliding ROP = 7.8 fph
    - Rotating ROP = 10.4 fph
    - Section ROP = 8.8 fph
    - Average = 7.3 days
Colony Wash – Curve (Cont.)

● Turbine and Impreg Development
  – Engineering wanted technology for horizontal drilling
    ➢ Geometry
    ➢ 2-23 Bits in the Lateral (Average = 8 bits)
  – Build the curve
    ➢ 1st Well
      » Build rates of 12°/100’
      » 1.5° Bend Turbine (7.66 rpg = +/- 1700 rpms)
      » Mid-body Stab, String Stab, full length bit
      » ROP = 16.7 fph (190% faster)
      » 9.5°/100’ TOOH to PU conventional tools
    ➢ 2nd Well
      » Same 12°/100’
      » 1.5 Bend on Turbine
      » No stabs, 4” shorter bit
      » ROP was 9.8 fph (50% better than motor)
      » 10.5°/100’ TOOH to PU conventional tools
Colony Wash – Curve (Cont.)

- 3rd Run
  - Set up for 12°/100’
  - Bend to 1.75°
  - Able to achieve 14°/100’ (Had to back off to prevent landing high)
  - Landed curve and drilled 256’ in lateral
  - Drilled 1158’ in 78 hours for 14.8 fph average
  - Beat best offset by 2.2 days and others by 4+days ($150k savings)
  - Set new technical limit for hole section

- 4th Run
  - Set up for 14°/100’ (moved KOP up about 20’ 13.4°/100’)
  - Getting 13.5°/100’ consistently
  - Beat best offset by 1.7 days and others by 3+ days
  - Tied previous technical limit hole section
Colony Wash – Curve (Cont.)
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- Consistently build curve at 14°/100’
  - Open hole and whipstock
  - High as 18°/100’

<table>
<thead>
<tr>
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<th>Delta</th>
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<tbody>
<tr>
<td>Overall Time, avg hrs</td>
<td>113</td>
<td>62</td>
</tr>
<tr>
<td>Drilling Time, avg hrs</td>
<td>79</td>
<td>29</td>
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<tr>
<td>Technical Limit, hrs</td>
<td>57</td>
<td>50</td>
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- 2011 Improvements: Consistent Rig to Rig performance with turbine
Colony Wash – Lateral

- Landing Point to Casing Operations
- Drill 6 1/8” Hole
- Small Target – 10’ window
- Bit Selection
  - Offset Data, Geology Mapping
    - Number of Bits in Lateral ranges from 2 – 23 (AVG = 8)
      - Heavy Set 6,7,8, and 9 blade PDC's
      - ‘627’ insert bits
- BHA
  - 1.5° Motor w/ kickpad  0.48 RPG, 5 Stage, 5/6 Lobe, BTB = 5.2’
  - 1.7° Turbine 7.44 RPG, 147 stage, BTB = 3’
    - 68% Time Rotating
      - ROP = 16.7 fph (4.5)
    - 32% Time Sliding
      - ROP = 8.7 fph (1.8)
Colony Wash – Lateral (Cont.)

<table>
<thead>
<tr>
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<th>Delta</th>
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<tbody>
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<td>Overall Time, avg hrs</td>
<td>540</td>
<td>37</td>
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<tr>
<td>Drilling Time, avg hrs</td>
<td>342</td>
<td>28</td>
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<tr>
<td>Technical Limit, hrs</td>
<td>230</td>
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- **2011 Improvements:** Continued use of turbines, bit development
The heavy lines represent the total rig time and the fine dashed lines to the left represent on bottom drilling time only.
Colony Wash – Time Summary
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Colony Wash – Time Summary
Colony Wash – Time Summary
Colony Wash – Summary

Colony Wash Performance

- **Best Well**
- **Average Well**
- **Composite Tech Limit Well**
Colony Wash – Summary

- Competition
- Quality Control
- Anadarko Team
Questions

Anadarko – Granite Wash Improvements

Craig Staley, Drilling Engineer – Anadarko Basin