HARTZOG DRAW

INTRODUCTION
NEAR HDU 5204
20 – 45N – 75W
Near HDU 5038
Sec 3 - 44N – 76W
• Discovered on August 24, 1975 by Southland Royalty

• Unitized in September 1, 1980 – Cities Services Designated as Operator
  • Water Injection Commenced in 1981 on 640 Acre Inverted Nine Spots

• Cities Services Merged with Occidental Petroleum (OXY) in Fall of 1982
  • Down-spaced to 320 Acre Five Spots in 1983
  • Down-spaced to 160 Acre Five Spots in 1985

• Exxon Purchased Hartzog Draw Field from OXY on November 30, 1989
  • Converted to 40 Acre Line Drive in 1996

• XTO Acquired Field from Exxon on May 21, 2004
  • XTO Drilled 16 Unit Wells and Continued Exxon’s Refrac program (1992 – 1999)

• Denbury Acquired the Field from XTO/ExxonMobil on November 1, 2012
  • Plans to Initiate a CO2 Tertiary Recovery Program
SOUTHLAND ROYALTY
BUD CHRISTENSEN #1
AUG 24, 1975
TD: 12,025’
IP: 425 BOPD
156 MCFGPD

WELLS DEEPER THAN 9500’ DRILLED PRIOR TO DISCOVERY WELL
COMPLETIONS 1976 – 1977

640 Acre Spacing

HDU WELL COMPLETIONS
- Discovery Well - Aug 24, 1975
- Completed 1976

HDU WELL COMPLETIONS
- Discovery Well - Aug 24, 1975
- Completed 1976
- Completed 1977
- Unitized Sept 1, 1980 under Cities Services
  - *After* taking 71 votes to have the required 75% acceptance of the Participation Formula
- Cities Services Merged with Occidental Petroleum (OXY) in Fall of 1982
- Exxon Purchased Hartzog Draw Field from OXY on November 30, 1989
- Water Injection Commenced in 1981 on 640 Acre Inverted Nine Spots
- Down-spaced to 320 Acre Five Spots in 1983
- Down-spaced to 160 Acre Five Spots in 1985
The Hartzog Draw Unit is a Federal Secondary Recovery Unit located in Campbell County, Wyoming.

- Comprised of 35,494 acres
- Denbury owns: 83.287% Working Interest, 71.06% Net Revenue Interest.
- Only the Shannon Sandstone interval from 9,162’ to 9,230’ in the Southland Royalty – Bud Christensen #1 is unitized. All other formations are owned and operated on a lease basis.
COMPLETIONS 1990 – 1999

Converted to 40 Acre Line Drive in 1996

Exxon Initiated Refrac Program in 1992 – 1999
COMPLETIONS 2000 – 2010
AND PRESENT (JULY 2013) WELL STATUS

XTO Acquired the Field from Exxon
May 21, 2004

XTO Drilled 16 Unit Wells and
Continued Exxon’s Refrac Program

Denbury acquired the Field from
XTO/ExxonMobil
November 1, 2012

July 2013
Producers: 165
Injectors: 136
SI Producers: 22
SI Injectors: 34
TA: 28
PA: 10
Dry: 14
Total: 409
HARTZOG DRAW
GEOLOGY
SHANNON SANDSTONE (Upper Cretaceous - 9,500’)

- Deposition: Incised Valley Trending NW – SE

- Tidal Bar Complex: Series of Prograding Sand Ridges - Single Sand Encased by Cody Shale (source and seal)

- Develops into 3 Lenses (Upper, *Main* and Lower)

- Stratigraphic Trap with 1-2° Southwest Dip

- No Gas Cap or Water Contact

- Average Porosity = 12% (2 – 28%)

- Average Permeability = 12md (0.02 – 113md)
SHANNON GEOLOGIC MODEL
INCISED VALLEY / TIDAL BAR COMPLEX

Estimated Location of Photo

Est. limit of preserved facies at HDU

From Sullivan et. Al., 1995
SHANNON STRATIGRAPHY

- **Upper Shannon Sequence**
  - Burrowed distal tidal bar deposits
  - Modifies the thickness of underlying Main Shannon (erosional)
  - Flooding surface (FS at top of this sequence separates the Shannon Sand with the overlying marine Upper Cody Shale)

- **Main Shannon Sequence**
  - Dominant reservoir
  - Proximal tidal bar deposits of trough cross-beds and current ripple marks
  - Thin distal tidal bar deposits of silty and shaly sandstone compose the lower portion of the sequence

- **Lower Shannon Sequence**
  - Defined by sharp slight angular discordance with underlying Lower Cody Shale
  - Marked by a basinward shift in facies with burrowed, distal tidal bars of shaly and silty sandstones
  - Thickness variation suggest that the Lower Shannon is an erosional remnant of a much more widespread deposit

HARTZOG DRAW
HDU 5292
TYPE LOG
w/ CORE PHOTO LOCATION

HDU 5292
T45N R75W S29
490052465100

TOP MAIN SHANNON
PHOTO A

BASE MAIN/TOP LOWER SHANNON
PHOTO C

BASE LOWER SHANNON

CUMOIL: 883,536
CUMGAS: 338,025
CUMWTR: 0
LOWER SHANNON CORE PHOTO

HARTZOG DRAW
HDU 3012
Photo D
MD 9575.6-81.3

Lower Shannon Laminated, Flaser and Wavy Bedding Structures w/ Bioturbation
## Average Composition of Shannon SS

<table>
<thead>
<tr>
<th></th>
<th>Cross-bedded &amp; Rippled SS</th>
<th>Laminated, Rippled &amp; Bioturbated SS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Framework Grains</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quartz</td>
<td>52.3</td>
<td>40.5</td>
</tr>
<tr>
<td>Chert</td>
<td>6.2</td>
<td>3.7</td>
</tr>
<tr>
<td>Glaucnite</td>
<td>6.7</td>
<td>3.7</td>
</tr>
<tr>
<td>Rock Fragments</td>
<td>11.4</td>
<td>11.9</td>
</tr>
<tr>
<td>Plagioclase</td>
<td>6</td>
<td>3.5</td>
</tr>
<tr>
<td>Siderite Clasts</td>
<td>0.3</td>
<td>1.7</td>
</tr>
<tr>
<td>Grains Replaced by Carbonates</td>
<td>0.7</td>
<td>5.7</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>83.6</strong></td>
<td><strong>70.7</strong></td>
</tr>
<tr>
<td><strong>Cements</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcite + Dolomite</td>
<td>2.6</td>
<td>3.2</td>
</tr>
<tr>
<td>Quartz</td>
<td>1.6</td>
<td>0.3</td>
</tr>
<tr>
<td>Chlorite</td>
<td>0.4</td>
<td>0.1</td>
</tr>
<tr>
<td>Brown, pore-lining clay</td>
<td>1.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Pyrite</td>
<td>1.2</td>
<td>2.1</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>7.3</strong></td>
<td><strong>8.2</strong></td>
</tr>
<tr>
<td><strong>Visible Porosity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>0.8</td>
<td>0.1</td>
</tr>
<tr>
<td>Dissolution</td>
<td>5</td>
<td>0.4</td>
</tr>
<tr>
<td>Moldic</td>
<td>0.9</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>6.7</strong></td>
<td><strong>0.6</strong></td>
</tr>
<tr>
<td>Detrital Clay</td>
<td>2.4</td>
<td>20.5</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Modified from Petrography, Diagenesis, and Facies Controls on Porosity in Shannon Sandstone, Hartzog Draw, Wyoming Ranganthan, Vishnu, & Tye, Robert S., AAPG Jan 1986
Note: The Shannon Sand is a stratigraphic trap with no water leg.
STRIKE STRATIGRAPHIC X-SECTION

NW

HDU S127
T45N R76W S12
490052809500
CUMOIL: 695.691
CUMGAS: 165.569
CUMWTR: 295.679

HDU S132
T45N R76W S13
490052444200
CUMOIL: 447.954
CUMGAS: 248.244
CUMWTR: 3.182

HDU 1951
T45N R75W S19
490052463300
CUMOIL: 29.307
CUMGAS: 9.031
CUMWTR: 295.621

HDU 6284
T45N R75W S29
490052463300
CUMOIL: 625.494
CUMGAS: 218.427
CUMWTR: 1

HDU S332
T45N R75W S33
490052685300
CUMOIL: 657.366
CUMGAS: 282.769
CUMWTR: 86

HDU 4037
T44N R75W S10
490052795000
CUMOIL: 1,172.604
CUMGAS: 282.713
CUMWTR: 352.378

HDU 1041
T44N R76W S10
490055639000
CUMOIL: 2,455
CUMGAS: 980
CUMWTR: 95.009

HDU 4148
T44N R75W S14
490055258000
CUMOIL: 784.679
CUMGAS: 203.570
CUMWTR: 283.755

HDU 2441
T44N R75W S24
490055259400
CUMOIL: 5.325
CUMGAS: 2.978
CUMWTR: 86.990

SE

Top Upper Shale
Top Water Shale
Base Water Shale
Base Upper Shale

Denbury

Click to edit Master title style
HARTZOG DRAW

RESERVOIR CHARACTERISTICS
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Porosity</td>
<td>12% (range of 2 – 20%)</td>
</tr>
<tr>
<td>Permeability</td>
<td>12md (range of 0.02 – 40 md)</td>
</tr>
<tr>
<td>Clay Content</td>
<td>As high as 30%</td>
</tr>
<tr>
<td>Oil Gravity</td>
<td>37 Degrees API</td>
</tr>
<tr>
<td>Reservoir Datum</td>
<td>4380 ft subsea</td>
</tr>
<tr>
<td>Initial Reservoir Pressure</td>
<td>5114 psig</td>
</tr>
<tr>
<td>Bubble Point Pressure</td>
<td>1550 psig</td>
</tr>
<tr>
<td>Initial Formation Volume Factor</td>
<td>1.1843 RB/STB</td>
</tr>
<tr>
<td>Initial Solution Gas Ratio</td>
<td>288 SCF/STB</td>
</tr>
<tr>
<td>Reservoir Temperature</td>
<td>194 Degrees F</td>
</tr>
<tr>
<td>Initial Oil Viscosity</td>
<td>1.217 centipoise (cp)</td>
</tr>
<tr>
<td>Initial Water Saturation</td>
<td>30%</td>
</tr>
</tbody>
</table>
**SHANNON OOIP**

**OOIP ORIGINALLY DETERMINED WITH AN ESTIMATED Soi = 70% (SW = 30%)**

<table>
<thead>
<tr>
<th>Field Data</th>
<th>Reservoir Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of discovery</td>
<td>Avg. depth to top of pay, ft (m)</td>
</tr>
<tr>
<td>Type of trap</td>
<td>9,400 (2865)</td>
</tr>
<tr>
<td>Producing formation</td>
<td>Avg. net pay (9% φ cutoff), ft (m)</td>
</tr>
<tr>
<td>Producing mechanism</td>
<td>20 (6.1)</td>
</tr>
<tr>
<td>Productive area, acres (10^6 m^2)</td>
<td>Volume of net pay acre-ft (10^6 m^3)</td>
</tr>
<tr>
<td>IOIP (volumetric)</td>
<td>630,400 (777.6)</td>
</tr>
<tr>
<td>MMSTB (10^5 stock-tank m^3)</td>
<td>Avg. porosity, %</td>
</tr>
<tr>
<td>353 (56.1)</td>
<td>12.3</td>
</tr>
<tr>
<td>IOIP (effective)*</td>
<td>Avg. air permeability, md</td>
</tr>
<tr>
<td>MMSTB (10^6 stock-tank m^2)</td>
<td>12</td>
</tr>
<tr>
<td>262 (41.7)</td>
<td>Avg. water saturation, %</td>
</tr>
<tr>
<td>Avg. depth to top of pay, ft (m)</td>
<td>30</td>
</tr>
<tr>
<td>Avg. net pay (9% φ cutoff), ft (m)</td>
<td>20 (6.1)</td>
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<td>Volume of net pay acre-ft (10^6 m^3)</td>
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<td>Avg. porosity, %</td>
<td>12.3</td>
</tr>
<tr>
<td>Avg. air permeability, md</td>
<td>12</td>
</tr>
<tr>
<td>Avg. water saturation, %</td>
<td>30</td>
</tr>
</tbody>
</table>

Source: Reservoir Management of the Hartzog Draw Field  SPE July 1982  
Robert D. Hunt, SPE, Cities Service Co.  
Charles L. Hearn, SPE, Cities Service Co.
Nearly all wells were completed as follows:

- **Surface casing**: 8 5/8” (below the Big George Coal)
- **Production casing**: 5 1/2”
- **Perfs**: 1 – 4 shots/ft
- **Treated with a pre-frac breakdown with crude oil or acid**
- **Hydraulically fractured with oil/water emulsion**
- **Size of frac treatment**: Ranged from 31,000 – 185,000 gal & 70,000 – 765,000 lbs sd
- **IP**: > 3000 BOPD in thicker portion of reservoir
- **Highest flow rate**: HDU 5333 – FARO 3,408 BOPD in 1977
- **All wells are on artificial lift, either beam pump or electric submersible pump**
HISTORICAL PRODUCTION
AUG 1975 – MAY 2013

Date          Cum Oil bbl     Cum Gas Mcf       Cum Water bbl   Cum Water Inj bbl
5/31/2013     117,704,016   41,357,379        37,198,790      168,826,933
PRODUCTION HISTORY AUG 1975 – NOV 2012

- **Peak Production Rate**: 39,028 STB/D
  - 120 Wells Oct 1977
- **Initiation of Water Injection**: 1981
- **Peak Production Rate Post Water Injection**: 18,967 STB/D
  - March 1987
- **Exxon Refrac Program**: 1992 - 1999
- **Cum Oil Produced as of May 2013**: 117.7 MMBO
- **Disc. Aug 24, 1975**

Detail next slide.
PRODUCTION HISTORY 2001 - 2013

XTO TOOK OVER OPERATIONS
Continued Refrac Program

XTO 2006 DRILLING PROGRAM
16 unit wells

DENBURY ACQUIRED FIELD
NOV 2012
GREENCORE CO2 PIPELINE
GREENCORE pipeline is approximately 12 miles from Hartzog Draw Unit.