Unconventional Resource Plays
Eagle Ford Shale Analysis
3-11-2011

Geology/Activity/Players

Best Practices

Geology/Stratigraphy

Eagle Ford structure dips regionally, to the southeast, with a subsurface depth of approximately 2,000' to 14,000'.

Geology/Structure and Isopach

Eagle Ford section varies in thickness between 30' and 300'.

Geology/Cross Sections

Eagle Ford seismic cross-section shows regional dip along with Buda marker.

Sequence stratigraphy well illustrated with digitised logs and hung on top of the Buda.

Geology/Petro Physics

Age: Cretaceous
Permeability: up to 0.13 md
Porosity: 4% to 15%
TOC: 1% to 4%
Fracture Nature: Brittle, high calcite
Thickness: 100 ft – 330 ft
Depth: 4,000 ft – 14,000 ft
Pressure Gradient: 0.6 psi/ft
Thermal Maturity: 0.5% to 2.2% R0
Primary Phase: Gas / Condensate / Oil
Hydrocarbons in Place: 40 – 225 BCF/section

Activity/Acreage Positions

EOG large leaseholder, but focused entirely in Oil phase.

Some lease positions in North East Eagle Ford, but largely undeveloped and uneconomic wells.

Laredo – small private company in Dry Gas window.
• Average term historically around 36 months (3 years)
• Operators will begin to “drill up” expiring acreage in 2010
• Could present problems for operator’s with assets in multiple shale plays
• Royalties slightly increased over time in each window
• Dry Gas royalty (27%) higher than Oil and Wet Gas (21%) in 2010

Eagle Ford is actually 3 different shale plays with 3 different set of characteristics—the “Windows”
• Operators beginning to “drill up” expiring acreage in 2010
• Total Depth getting smaller in oil window but laterals getting longer
• Dry Gas window — very little permit activity. Also, deepest area with largest total depth.
• Wet Gas — horizontal lengths the same as oil window

Activity has increased significantly in 2010 with best gas wells in the Condensate Window
Activity in the Oil Window is just starting to accelerate with best wells in the Karnes County area
**Activity/Top Producers**

- EOS has recently displaced Chesapeake at the largest producer of Eagle Ford oil.
- A number of operators are on the verge of catching Chesapeake in the case of gas.

**Activity/Max IP Rate to Cum Prod**

- R² increases significantly when using Max IP (peak monthly production) instead of IP Rate.

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**Best Practices/Well Bore Design**

- **Well Bore**
  - Vertical depth: 7,000 to 10,000 ft
  - Laterals length: 3,500 to 7,000 ft
- **Cemented Cased Hole**
- **Two string casing designed with tapered Long String**
- **Fractured section**
  - 10-18 Stages, 250-500 ft each
  - Perforations clustered every 50 ft

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**Best Practices/Well Spacing & Azimuth**

- Could be important when examining wells that are close in proximity.
- No strong correlation on a play level.

**Typical Oil Window**

- Spacing: 1,300' between laterals.
- 120 acres/well.

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**Best Practices/Lateral Length**

- Average Eagle Ford (Horizontal: 5,500 ft).
- In March: Incremental length vs. Well Count.

**No benefit to longer horizontal after 5,000 ft in Oil window.**

- Only marginal gains in Max IP after 5,000 ft in Wet Gas window.
Most operators are now following the lead as Best Practices evolve.

- Operators have been able to cut well cost by $800k through the elimination of intermediate casing strings.

**Eagle Ford Analysis**

**Best Practices/Casing Program**

**Best Practices/Frac Design**

**HiWay Fracs**

- Decouples fracture productivity from proppant permeability and creates flow channels.
- Instead of flowing through the proppant, hydrocarbons flow through channels—a significant increase in conductivity.
- Conductivity extends all the way to the tip of the fracture for optimised production with superior recoverability.
- Benefits include: improved production through infinite fracture conductivity, lower artificial lift cost, and reduced well completion and land.

**Best Practices/Simul-Frac Design**

- A simulfrac is when two or more somewhat parallel wellbores are frac'd at relatively the same time.
- Barnett Shale impact of Simulfracing - 200-400 MCFE/D more production (on average) in peak month.
- SM Energy and EOG actively using SimulFrac technology in Eagle Ford.
- EOG using vertical offset wells to monitor pressures and the interaction between wells.
- Simulfrac also successful in other unconventional resource plays.

**Simul-Frac Pilot**

- Two wells drilled on 120 acre spacing; test to advance knowledge of ultimate spacing for development.
- Wells used 17 stage completions over approx. 5,600 ft laterals.

**Best Practices/Prod Flow Rate**

- Big Eagle Ford players, such as SM Energy, Petrohawk and EOG, are experimenting with this practice.
- This practice gained momentum in the Haynesville Shale as the extreme overpressure caused wellbore and reservoir deterioration.
- Petrohawk states 30% increase in EUR.

- The pressure is higher in the restricted well when the production curve meets.

**Eagle Ford Analysis**

**Best Practices/Frac Design**

**Hybrid Fracs**

- Well-suited for condensate and oil windows.
- Use of gelled fluids allows the placement of higher concentrations of larger proppant.
- Generates higher, more uniform fracture conductivity.
- Highly viscous fluids create better diversion into all perforations.
- Less water used versus slickwater only.
- Use of a slickwater pad in front of the gelled fluid helps create a complex fracture network.

**Best Practices/Microseismic**

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Best Practices/Creaming-Learning Curves

- Wet gas results of all three windows
- Dry gas beginning "cream over" due to depressed gas prices and little focus in area
- Oil continuing to make gains in production

Best Practices/Operator Performance

- Curve indicates significant improvement in performance by Conoco

Best Practices/Reserves & Economics

- Hawkville Gas
- Hawkville Wet
- Sugarkane-Blackhawk
- Maverick Basin

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In-Depth Play Analysis, Up-Dated Quarterly

- U.S. Shale Plays

Consulting Services Offered

- Technical Experts, Focused on Unconventionals
  - Geologists
  - Geochemists
  - Geochemistry
  - Petro-Physicists
  - Well Planning/Project Managers
  - Drilling Engineers
  - Completion Engineers
  - Reservoir Engineers
  - Economic Analyst
  - Regulatory Analyst
  - Environmental Analyst

- Providing Detailed Analysis
  - Play selection
  - Acquisitions
  - Joint Ventures
  - Development Programs

- Supporting Technology Transfers
  - Analog Identification and Analysis
  - Best Practices Determinations
  - Operator Performance Rankings
  - Service Provider Assessments