2009 AADE Mid Continent Chapter Symposium

Northeast US Operations
January 14, 2009

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Agenda

2009 AADE Mid Continent Chapter Symposium
Northeast US Operations
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- Overview of Eastern US
- Geology
- Operations
- Lesson's Learned

Donald Rumsfeld at a Defense Department Briefing on February 12, 2002:

" There are known knowns. There are things we know that we know. There are known unknowns. That is to say, there are things that we now know we don't know. But there are also unknown unknowns. There are things we do not know we don't know."

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Chesapeake and Shale Plays

- Overview

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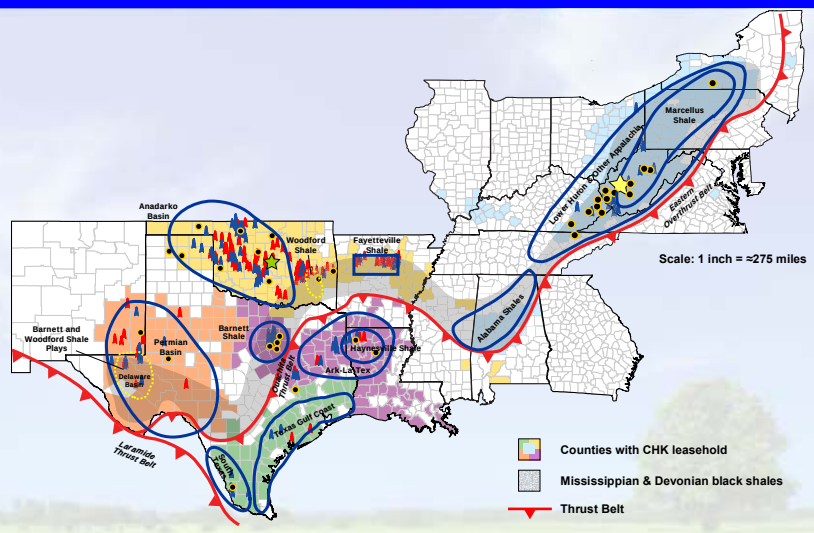
Location of CHK Properties



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Appalachian Basin Statistics

- First oil in U.S. – 1859 drake discovery, Venago County, Pennsylvania @ 70 feet in Devonian Sandstone. 1823 first gas discovery made in Fredonia, NY.
- Basin area: 185,000 square miles (118.4 mm ac) across 9 states and southern Ontario
- Appalachian Basin = 2/3 size of Texas, 3x state of Oklahoma
- Cumulative production 42 Tcf (7 Bboe) + 3 billion bbls oil = 10 Bboe produced
- 257,000 wells in PI, 500,000+ total in basin?
- Gas production approximately 2.0 Bcf/d, approximately 4% of U.S. production
- New plays are emerging in deeper sections of basin, in unconventional tight gas shales (source rocks), sandstones, and hydrothermal dolomites.
- 3-D seismic will reinvent the basin...
- Marcellus Shale (31 MM ac.) is "Looming Giant" that will dwarf the Barnett Shale (2.7 MM ac.)!

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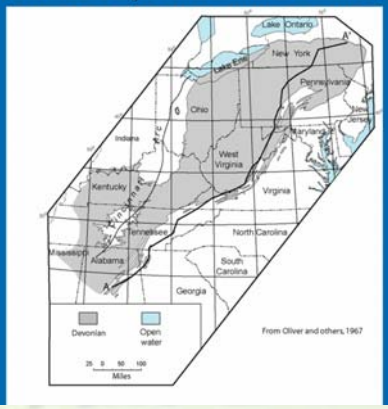
Early USGS Map of Devonian Shale Extents

USGS

Extent of Devonian Shale in Eastern U.S. – Section A-A' (Oliver and others, 1967)



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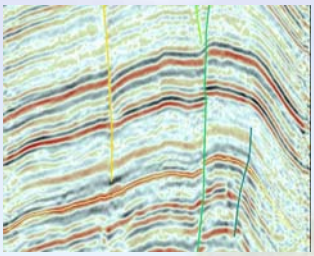
Marcellus Shale Play Section

- Geology Review



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Appalachian Basin Petroleum Systems

Huron Shale

Devonian Section

Marcellus Shale

Ohio, Huron, Marcellus Shales

Ordovician Section

Utica Shale

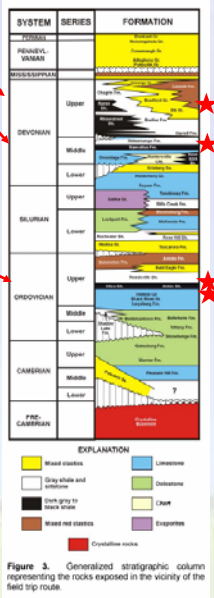

Figure 3. Generalized stratigraphic column representing the rocks exposed in the vicinity of the field trip route.

USGS -30 Plays Identified

Alleghenian Orogeny

Paleo-reconstruction

Acadian Orogeny

Trenton-Black River Dolomite

Taconic Orogeny

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Shale Basins

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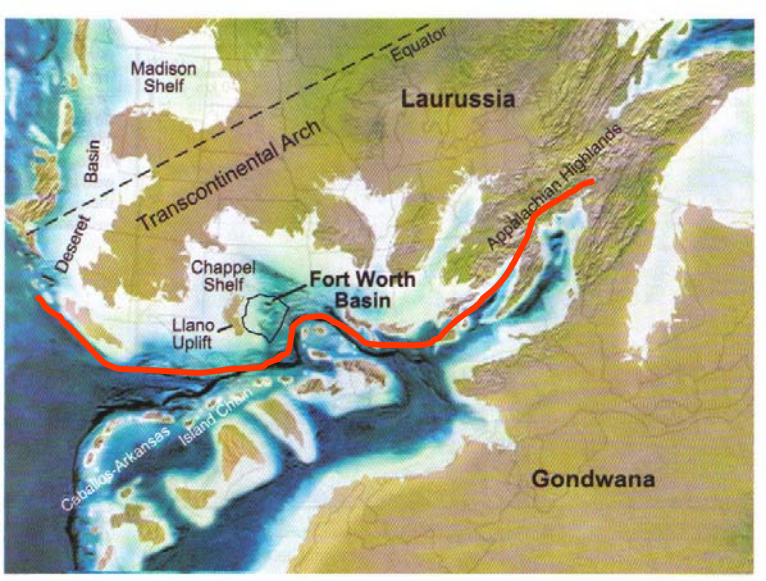
Early Mississippian ~360 MYA



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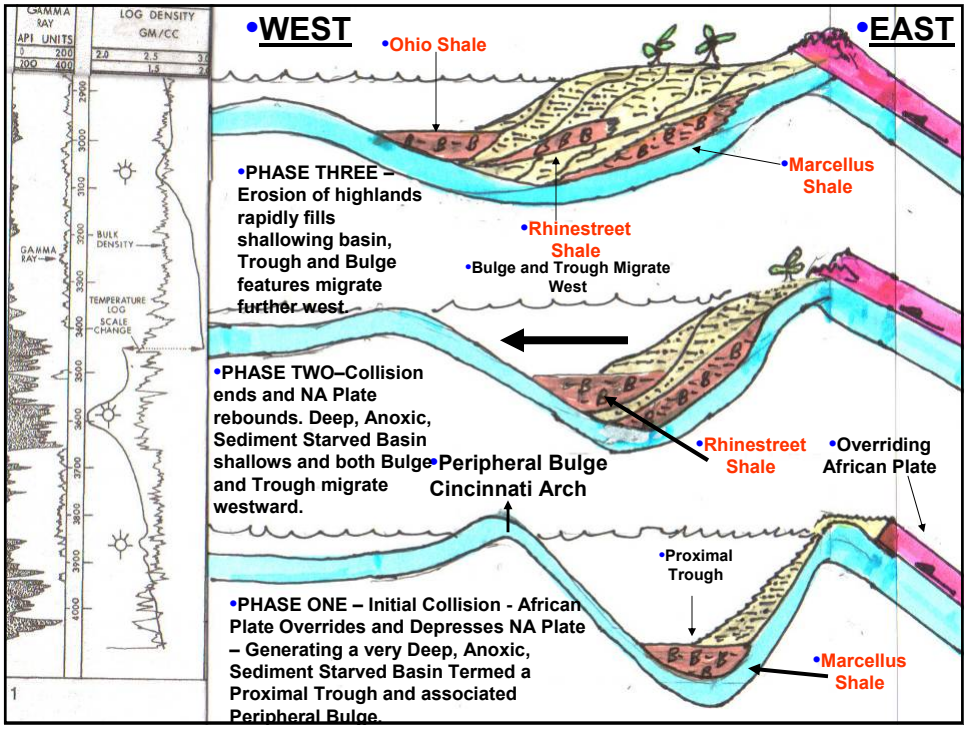

OK – But What Does This Mean?

- Barnett Shale
  - High Gas Yields – High Success Rates
  - May be the largest natural gas field developed in the U.S.
  - Development of new technologies in horizontal drilling and hydraulic fracturing
- Barnett Shale and Marcellus Shale
  - Although separated by 30 MY in time, both were generated by a similar depositional system and tectonic setting
  - Both were the initial sediments deposited in a very deep, sediment starved, anoxic trough that formed in response to an impinging tectonic plate
- Marcellus Shale
  - Deep water depths – maximum preservation on organic material and higher maturity
  - Minimal Bioturbation resulting in maximum preservation of silt laminae and increased lateral permeability

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Operations and Production Section

- Operations

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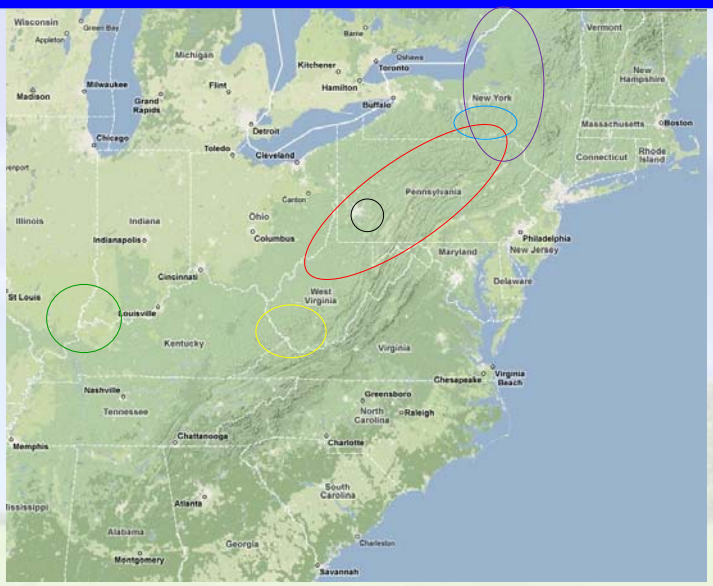
Eastern US Areas of Interest



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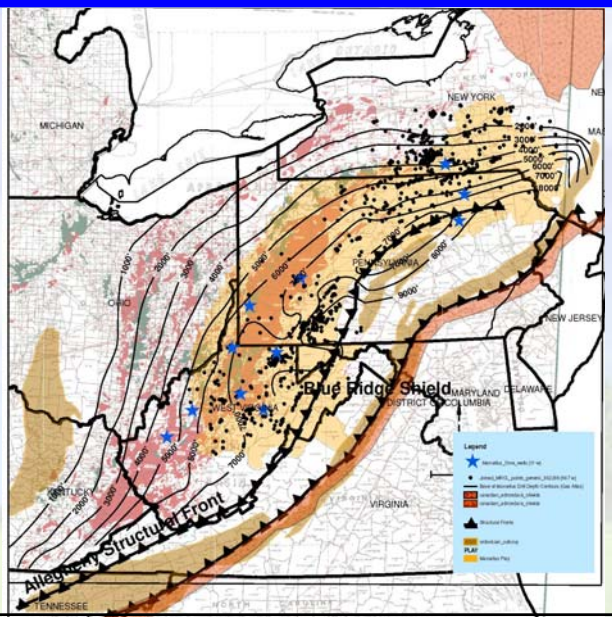
Marcellus Footprint and Drill Depth Map

Marcellus Footprint
31 MM acres



966 data points
11 core sites

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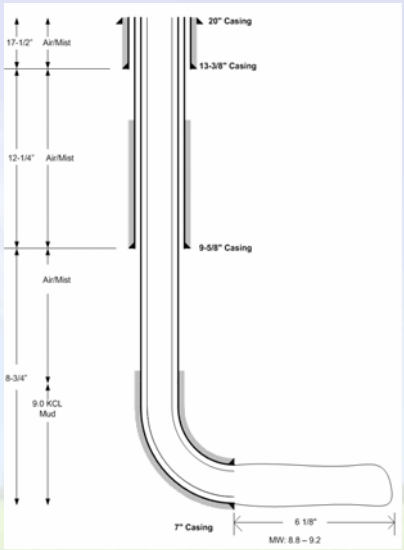
Black River Wellbore Schematic



Drilling Procedure

Hydrothermal Fractured Dolomite Formation

- **Drill 17 ½" Surface hole on air**
- **Set 13 3/8" casing and cement to surface**
- **Drill 12 ¼" hole on air – Evaluate hole conditions**
- **Set 9 5/8" casing and cement – if required**
- **Drill 8 3/4" on air to KOP and switch to brine based mud**
- **Drill from KOP and build angle at 12° per 100' to top of Black River Formation**
- **Set 7" casing and cement**
- **Drill horizontal leg from 1,500' to 4,000'**
- **Total drill days = 30 days**

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Drilling Program

Possible Problems:

- Shallow Gas Potential
- Salt Sections in 12-1/4” Hole
- Very Unstable Vernon Shale in 12-1/4” Hole
- If these problems are minimized then by-pass the 9-5/8” casing
- Fluid requirements for the Salt and Vernon shale must be maintained while building to horizontal
- Lost circulation / returns while drilling fractured Dolomite formation

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CHK Marcellus Wells Drilled to Date

- **Re-entered 6 well bores to test Marcellus beginning July 2006**
- **Initial vertical Marcellus test well spud March 2007**
- **Drilled 19 vertical Marcellus wells**
- **Cored 6 vertical test wells thru Marcellus (analyzed 11 Marcellus cores)**
- **Initial Horizontal well spud August 2007**
- **Drilled 15 horizontal wells – all successful**
- **19 vertical and re-entry Marcellus wells on line**
- **6 Horizontal Marcellus wells on line**

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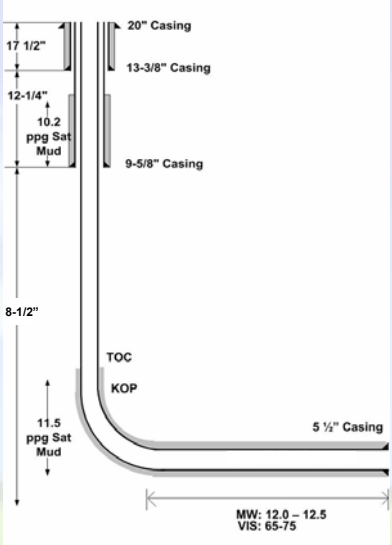
Marcellus Wellbore Schematic



Drilling Procedure

Storage Fields

- Drill 17 ½" Surface hole on air
- Set 13 3/8" casing and cement to surface
- Drill 12 ¼" hole on air to storage zones and then switch to brine based mud
- Continue 12 ¼" hole to below storage zones
- Set 9 5/8" casing and cement to above storage zones
- Drill 8 1/2" on air to KOP and switch to brine based mud
- Build angle at 12° per 100'
- Drill horizontal leg from 3,000' to 5,000'
- Total drill days = 25 days

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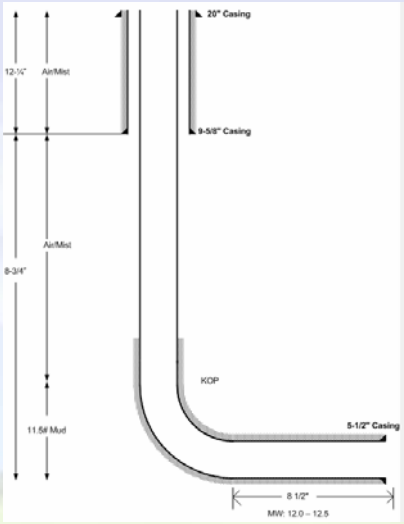
Marcellus Wellbore Schematic



Drilling Procedure

- Drill 12 ¼" hole on air
- Set 9 5/8" casing and cement
- Drill 8 3/4" on air to KOP and switch to brine based mud
- Build angle at 12° per 100'
- Drill horizontal leg from 3,000' to 5,000'
- Total drill days = 21 days

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Drilling Program

Possible Problems:

- Lost Circulation Zones below the 9-5/8” casing
- Directional / Targeting issues in areas without 3D Seismic
- Pad Drilling / Anticollision
- Marcellus Shale Stability
- Hole Cleaning in Extended Reach Horizontals

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Drilling Program Opportunities

Efficiencies expected from:

- Pad drilling – expect up to 6 laterals per Pad
- Learning curve efficiencies
- Reduce days & costs with repeatable program
- Water based mud in laterals
- Reduce motor/MWD inefficiencies
- Increased vendor competition
- Economies of scale

Coach Red Beaulieu: “That's kinda like my old man told me one time, Lynn. The only thing better than a crawfish dinner, is five crawfish dinners.”

The Waterboy

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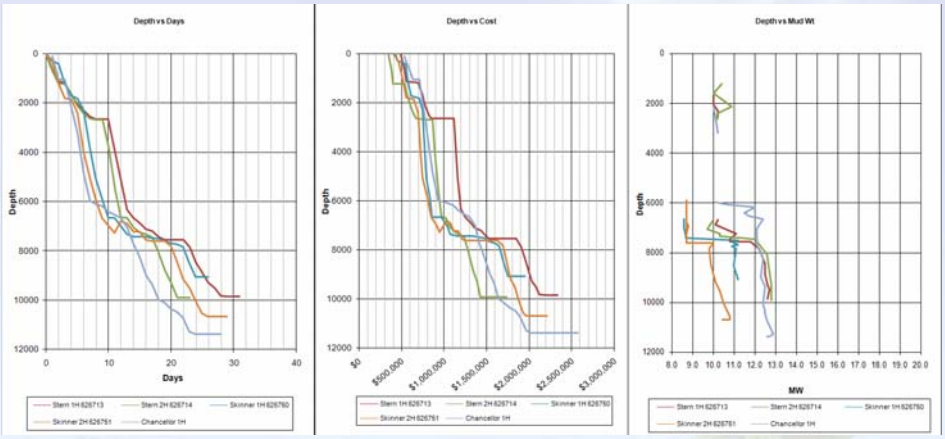
Improve As We Grow – Learn As We Expand



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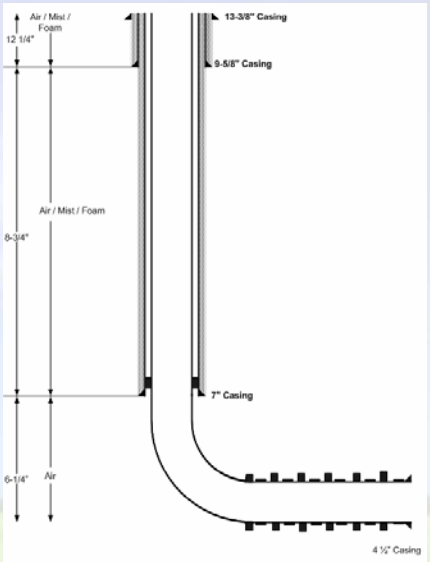
Lower Huron Wellbore Schematic



Drilling Procedure

- **Drill 12 ¼" hole on air**
- **Set 9 5/8" casing and cement**
- **Drill 8 3/4" on air to KOP**
- **Set 7" casing and cement**
- **Build angle at 10° per 100'**
- **Drill horizontal leg from 2,500' to 4,000'**
- **Total drill days = 15 days**
- **Run 4-1/2" Isolation String for completion**

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Drilling Program

Possible Problems:

- Water flow below the 9-5/8” casing – instability
- Dry Air Drilling Horizontal Sections – Tool Reliability
- Lower Huron Shale Stability
- Flaring Gas while drilling on air
- Tripping with Gas pressure

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Lesson's Learned

1. The Geologic Model works
- **Not all acreage will be prospective**
- **Establish core drilling areas for focus as new rigs arrive**

2. The Rock Rules
- **Adapting drilling and completion techniques to various areas**

3. People are the key
- **Strong Supports Teams are required (Contractors, Service Providers, Transportation)**
- **Resources from Barnett, Fayetteville, Woodford, and Haynesville**

4. Understand the full process and time requirements
- **Sourcing different water supplies**
- **Sourcing different water disposal outlets**
- **Changing service requirements**
- **Fit-for-purpose rig designs**

5. Education process for landowners, local and township governments, state government, local and state regulators

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