New and Innovative Drilling Technologies

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Outline

- Introduction to DOE-NETL
- YMP Unsaturated Zone Sampling Program
  - Drilling/Sampling Objectives Summary
- Drilling/Sampling Concept
- Coring/Sampling Concept
- Anatomy of YMP’s Purpose Built Drilling System
  - LM-300 Specifications
  - LM-300 Rig System Layout
- Purpose Built Concept Applied to Oil & Gas Industry
  - LM-700
  - Hybrid Coiled Tubing Rigs
  - Microhole Technology
**MISSION**
Advancing energy options to fuel our economy, strengthen our security, and improve our environment

- Pittsburgh, PA
- Morgantown, WV
- Albany, OR
- Fairbanks, AK
- Sugar Land, TX

= Lab Facilities

**Locations:**
- Oregon
- Pennsylvania
- West Virginia
Developing the critical science and technology to discover and commercialize advanced energy systems that efficiently utilize domestic resources in an environmentally sustainable manner
YMP Unsaturated Zone Characterization Program (Geologic and Hydrologic Requirements)

Drilling/Sampling Objectives Summary

- Obtain 2.4” diameter core containing the in situ conditions of the mountain
- Provide 12-1/4” boreholes for hydrologic testing without disturbing the in situ conditions of the mountain
Drilling/Sampling Concept Developed
(Based on Dry Drilling and Coring Technology Workshop Input)

Drilling

- **High Pressure Air in Orange:**
  - Transmitted to bit via dual wall pipe
  - Provides energy to move cuttings to center of bit/pipe

- **Vacuum Return in Blue:**
  - Vacuum system helps transport cuttings to surface up center of dual-wall pipe (DWP)
  - Injection and Return Air Volumes Balanced
    - No Net Air Charge at Bottom of Hole - Minimal Impact on Hydrology

![Diagram of drilling system with labels for Dual-Wall Pipe, Bit Body, Jet, and Roller Cones]
Coring/Sampling Concept Developed
(Based on Dry Drilling and Coring Technology Workshop Input)

Coring

- **High Pressure Air in Orange:**
  - Transmitted to core bit via core rod
    - Normal Wireline Coring Operations
  - DWP Left in Place to Protect Core Rod from Highly Fractured Intervals
    - Core Taken Through Open Center of DWP

- **Vacuum Return Air in Blue:**
  - Vacuum system helps transport cuttings to surface up annulus between core rod and DWP
Surface System: LM-300 Specifications

RIG DIMENSIONS:

- OVERALL HEIGHT - 84'
  W/MAST ERECT
- OVERALL WIDTH - 10'
- OVERALL HEIGHT W/MAST
  IN TRANSPORT POSITION - 15'
- LENGTH OF MAST - 80'6''

DRILLING CAPABILITIES:

PRIMARY AND SECONDARY POWER FOR - 2 CUMMINS KTA19,
HYDRAULIC/DRIVE SYSTEMS 600 HP EACH

POWER TO TOPHEAD DRIVE - 371 HP
MAX. MAST LOAD - 300,000 LBS
PULLBACK CAPABILITY - 238,500 LBS
PULLDOWN CAPABILITY - 30,000 LBS
MAIN HOIST - LONGYEAR 600, 4 SPEED W/3000' OF 1/4'' LINE
  AND 70,000 LB PULL CAPABILITY
PIPE HANDLING WINCH RATING - 5,000 LBS
MAX. TUBULAR LENGTH - 40'
MAX. TUBULAR DIAMETER - 60''
LM-300 Rig System Layout

“Fingerboard” to rack core rod for fast tripping

Condenser and Separator

Dual 900 CFM Compressors

Dust Filter

Cuttings Cyclone

Vacuum Blower

Return Line from Dual-Wall Pipe

Core Rod Rack

Gripper for DWP Handling System

9-5/8” Dual-Wall Pipe
LM-300 Concept Adapted for Oil & Gas Industry
The LM-700 Drilling Rig

LM-700 RC Drilled Severe Lost Circulation Basalt Zone to 7,800’

Conventional Rig Drilled Rest of Section to 14,000’
CTD Demo for Marginal Oil and Gas Resources

High Efficiency Technologies for Unconventional Gas

Objectives

• Demonstrate first high efficiency hybrid CT rig built and operating in U.S.

Accomplishments

• Drilled 25 wells in the Niobrara
  – 300,000 feet of hole in 7 months
  – Drilled and completed 3,000’ wells in 19 hours

Benefits

• Made 1 Tcf of shallow bypassed tight gas in Niobrara economic
• Reduced the cost of drilling wells by 25-38%
• Reduced environmental impact
Access: Coiled Tubing Drilling Reduces Drilling Cost and Environmental Footprint
Rapid Growth of Coiled Tubing Drilling
The New Wave of High Efficiency Technologies

- Denver Post (Jan 2007) –
  Business Section Front Page
  Article Attributes CT Drilling Boom in Colorado to DOE
  “The technology got a thumbs up after
  NETL (in conjunction with ADT and
  Rosewood Resources) drilled 25 small bore
  wells with CT rigs in the Niobrara formation
  in eastern Colorado and western Kansas”

- Oil and Gas Investor: “Microholes and Coiled Tubing” (March 2007)
  – Microhole Field Demo success in Niobrara detailed

  All Over – Smallbore Drilling Hardware Could Extend the Reach of
  CT Drilling” (March 2007)
  – Feature on Counter-Rotating Tandem Drilling System

Hybrid Coiled Tubing Drilling Rigs Now Have 12/14,000’ coil/rotary capability
CO₂ Project Results at Teapot Dome, WY
Using VSP Microhole Technology

Demonstrate Microhole/Downward Looking VSP  
LANL/LBNL

**Objective**
- Demonstrate improved high resolution active seismic (uses man-made sound source)
- Demonstrate cost effectiveness of shallow, low cost, VSP instrument boreholes for continuous monitoring with active and passive seismic (uses naturally occurring sound source)

**Accomplishments**
- Shallow Microhole VSP “sees” up to 4 times (or more) shallow hole depth
- Up to three times better resolution than VSP in conventionally drilled boreholes (much better signal to noise ratio)

**Benefits**
- Permits use of microholes for low cost, rapid VSP deployment because sensors do not need to be placed at reservoir level
- High resolution seismic surveys can be faster and much cheaper with permanently installed shallow, instrument boreholes
- Cost effective, permanent VSP boreholes could revolutionize complex reservoir characterization and long term EOR monitoring
Seismic Monitoring Well Location Plan

Seis.Mon.Well #1

5,000'

Horiz. Mid Point

North Horizontal Producer

~1,600'

Horiz. Monitoring Well

~1,600'

Horiz. Mid Point

South Horizontal Producer

~4,243'

Seis.Mon.Well #2

~8,485'

Seis.Mon.Well #3
**Status of Small, High Energy Drilling Systems**
*(for Rapid VSP Deployment)*

- **Strengths**
  - Very mobile
  - Small footprint
  - Two man crew
  - 7,500 PSI System

- **Weaknesses**
  - Relies on small oilfield motors
  - ROP limited
  - Mud based
    - Lost Circulation

- **Strengths**
  - Very mobile
  - Small footprint
  - ~7,000 PSI System
  - High ROP in hard rock potential

- **Weaknesses**
  - Jet must be controlled
  - Hi Press motor needed if bit used
  - Mud/fluid based
    - Lost Circulation

- **Strengths**
  - Air transportable
  - Very Small footprint
  - One man crew
  - Almost no fluid/air
  - 1500’ achievable with 30 HP system

- **Weaknesses**
  - SBIR PhI success only; no PhII demo
  - PhII SBIR not funded
  - SBIR short of funds
Future High Energy Drilling Systems?
(for Rapid VSP Deployment)

Specific Energy vs. Power for 0.5 Second Laser Exposure

Laser-Rock Reaction Zones Across a Range of Calculated Power Densities

Nd:YAG Laser-Rock Reaction
Questions