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The Global Energy Challenge:
Reviewing the Strategies
for Natural Gas


New Albany Shale Gas Research Project

Kent F. Perry

gti

Gas Technology Institute
Des Plaines, Illinois
U.S.A.

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Topics

- **New Albany Shale – Location and Potential Gas Resource**
- **Project Goals and Objectives**
- **Project Results**
 - **Geologic Assessment**
 - **Drilling and Completion**
 - **Well Stimulation – Hydraulic Fracturing**
 - **Production Methods**
 - **Gas Production and Gas Reserves**
 - **Summary**

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New Albany Shale Research Project Objectives:

- A field-based research project to identify critical parameters controlling commercial production from NAS
- Develop techniques for improving exploration success, production and ultimate recovery through:
 1. Characterization of the New Albany Shale Resource.
 2. Development of effective exploration, drilling, and completion Technology.
 3. Field Testing of results.
 4. Dissemination of results across the Illinois basin and other geologically similar basins.

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➤ Industry Partners

- Aurora Oil and Gas
- CNXGas
- Diversified Operating
- Noble Energy
- Trendwell Energy
- NGAS
- Deka Exploration
- Atlas America
- Breitburn Energy
- Inflection Energy

➤ Research Team

- GTI
- Amherst College
- Bureau of Economic Geology
- Pinnacle Technologies
- ResTech
- Texas A&M
- West Virginia University



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Research Team

Geologic Studies
BEG

Geochemical Analysis
Amherst & U Mass

Reservoir Engineering
Texas A&M

Fracture Modeling and Diagnostics
Pinnacle & Texas A&M

Best Practice Analysis
West Virginia University

Field Data Acquisition, Environmental Studies, Coordination and Integration
GTI

Formation Evaluation
ResTech

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U.S. Shale Gas Basins

Niobrara

Green River

Monterey

McClure

Cane Creek

Lewis & Mancos

Barnett & Woodford

Penn

Barnett

Woodford

Caney & Woodford

Fayetteville

Neal/Floyd & Conasauga

Gammon

Bakken

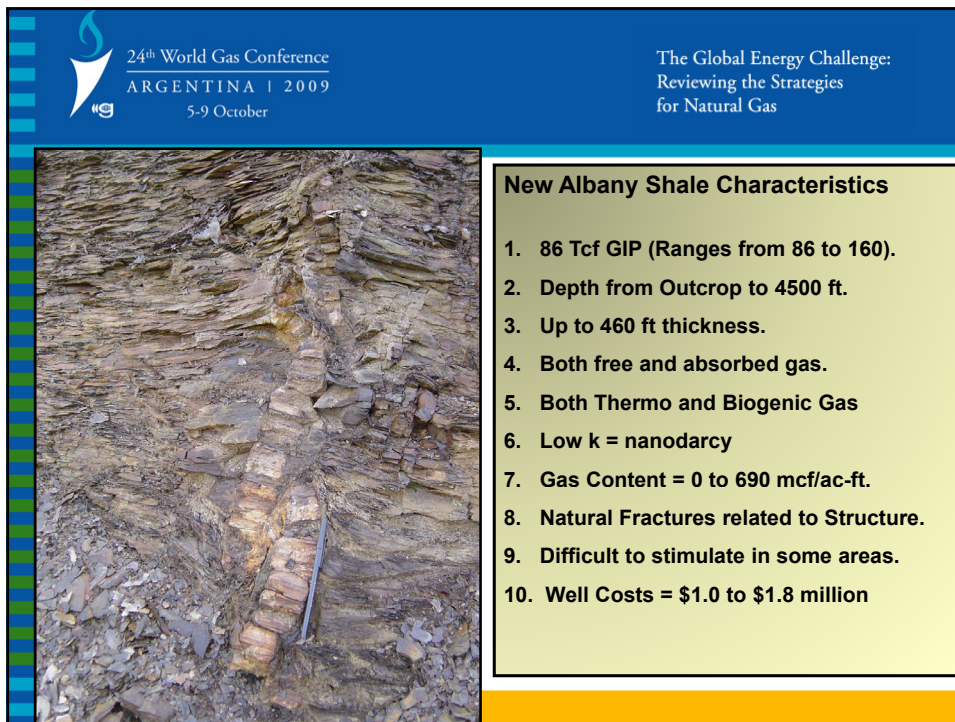
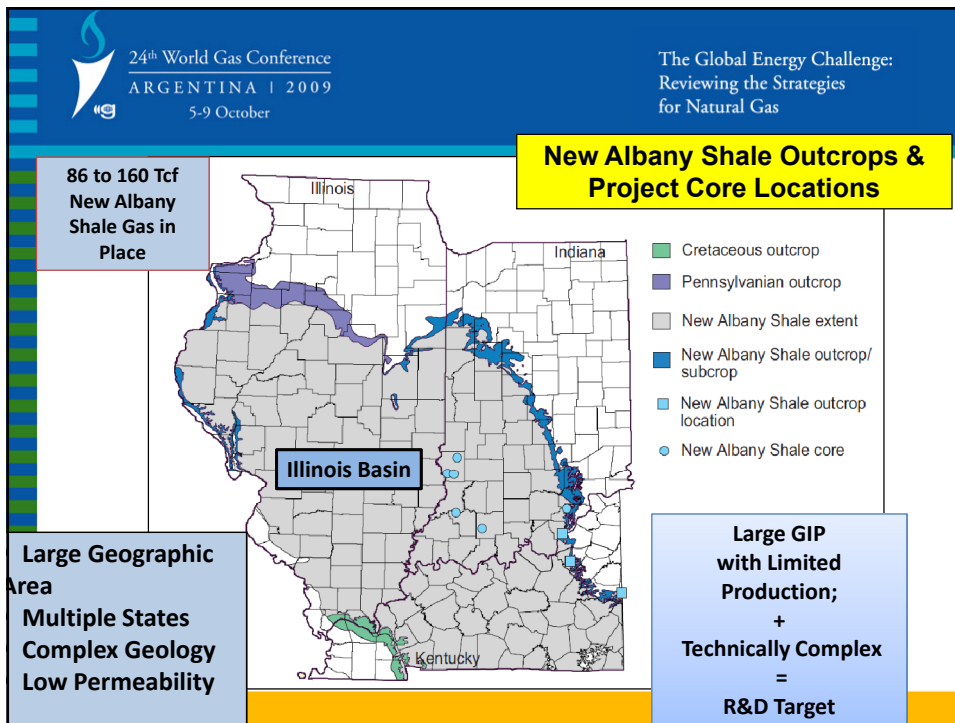
Excello/Mulky


New Albany

Antrim

Devonian/Ohio & Marcellus

Schlumberger Map






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New Albany Shale Natural Fractures



New Albany Shale

- Large vertical fractures
- One primary set of vertical fractures
- Fracture orientation is East-West
- Occurrence of North-South fracturing is limited

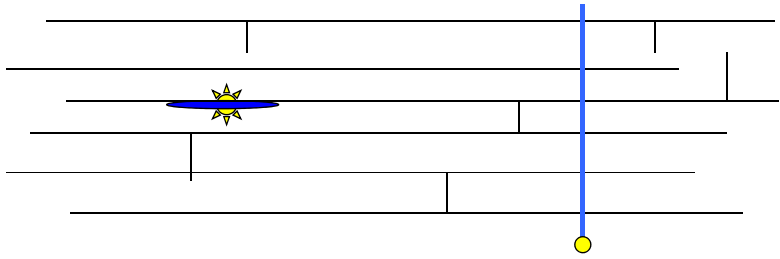


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Characteristics of Natural Fractures

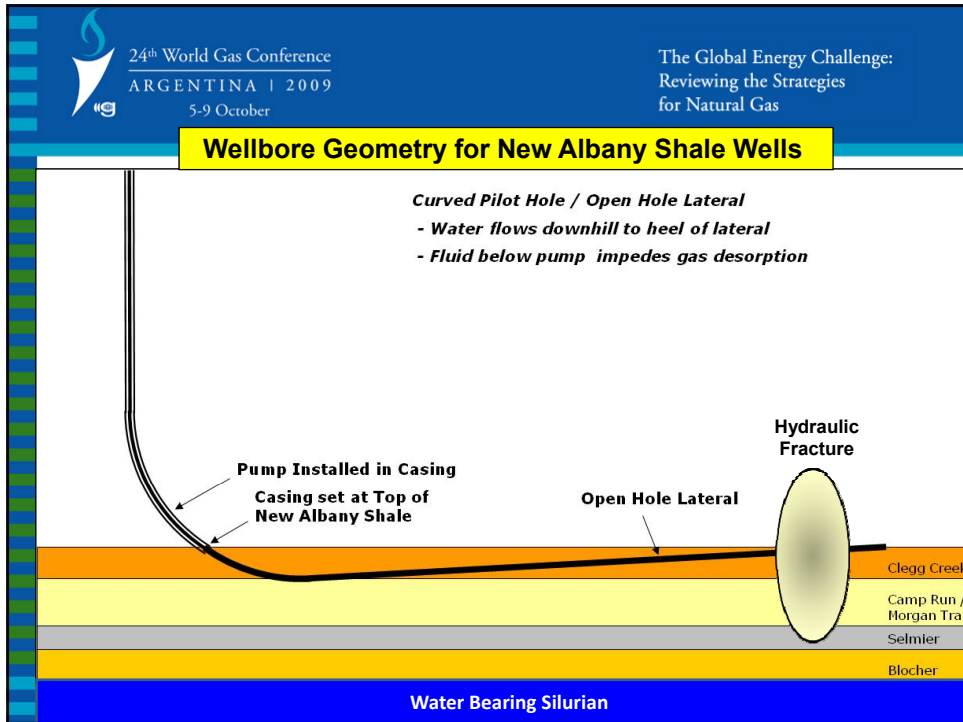
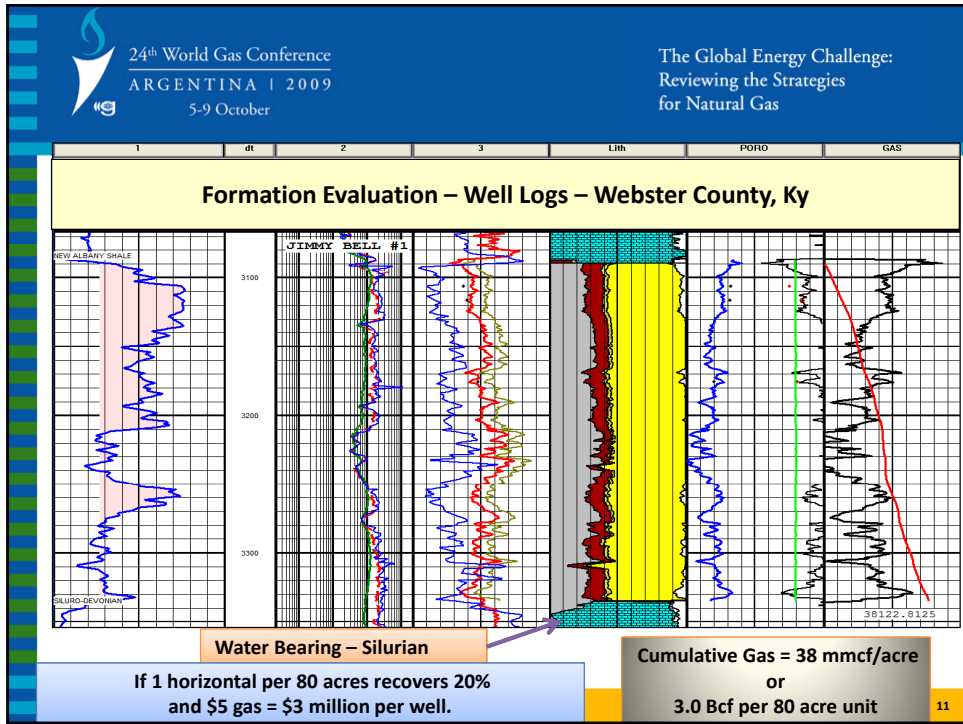
*Orthogonal Vertical Fractures
Non-uniform Spacing*



**Vertical Well with
Fracture Stimulation**

Horizontal Well



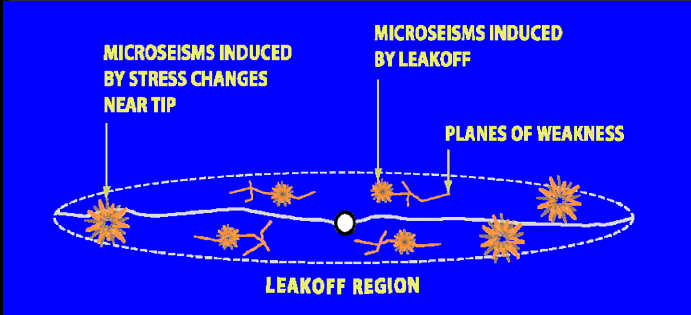
Horizontal Drilling is the only effective means to connect fracture planes



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Microseismic Fracture Mapping
Measure frac height, length and azimuth
in real-time



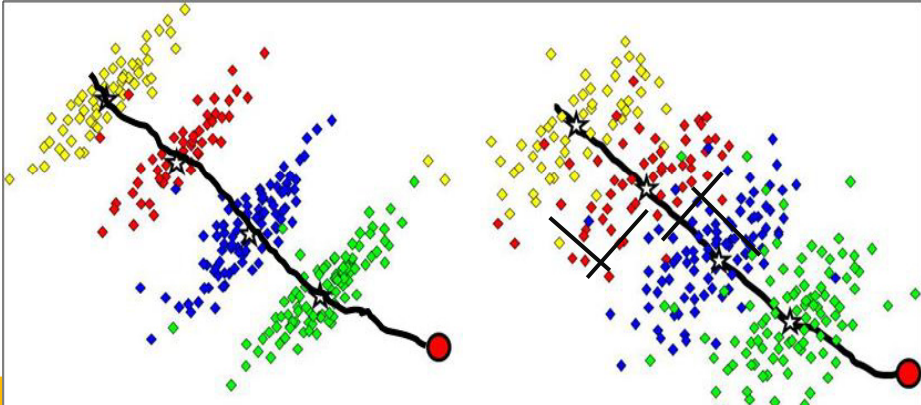
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**Hydraulic Fracture Stimulation of Horizontal Wells -
Microseismic Monitoring**

A simple bi-wing induced fracture may be an indication of lack of natural fracturing.

Fracture network may consists of multiple parallel and orthogonal induced fractures precluding accurate modeling.

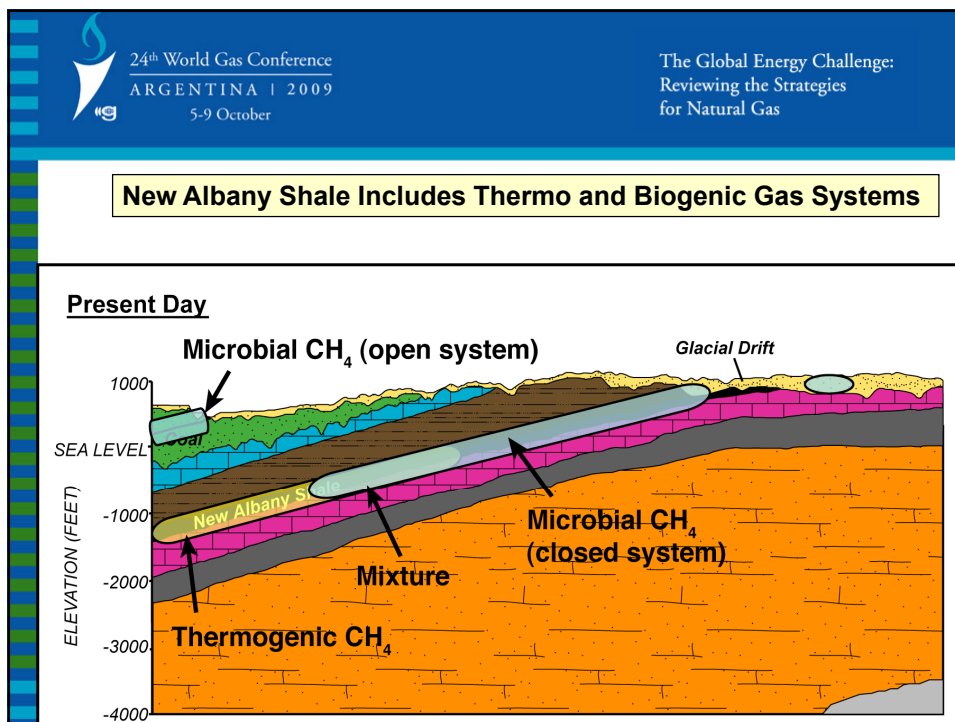


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Hydraulic Fracturing Fluids


- Large water-fracs in shallow, normally pressured shale may not be viable
- Substantial experimentation with 70 – 85Q foam
 - Large foam fracs may work in terms of preventing water blockage, but generally have unacceptable μ .
 - 80 – 100 times the vis of water
 - 4,000 – 5,000 times the vis of N_2
 - Low μ promotes network complexity
 - High μ promotes fracture simplicity
- Straight N_2 utilized in shallower NAS almost exclusively.
- Some limited MistFracSM, Vapor Frac, and other +95Q systems experimentation.
- Major paradigm shift may be necessary, as N_2 completions alone may not meet minimum production expectations to stimulate extraordinary Wall Street interest



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Surface Terrain

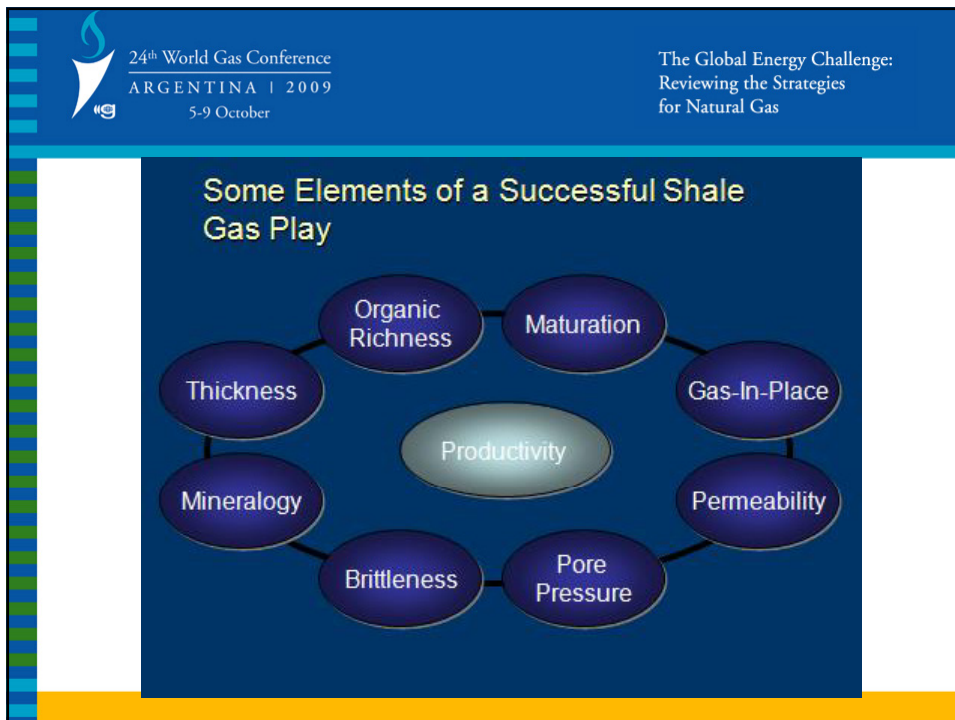
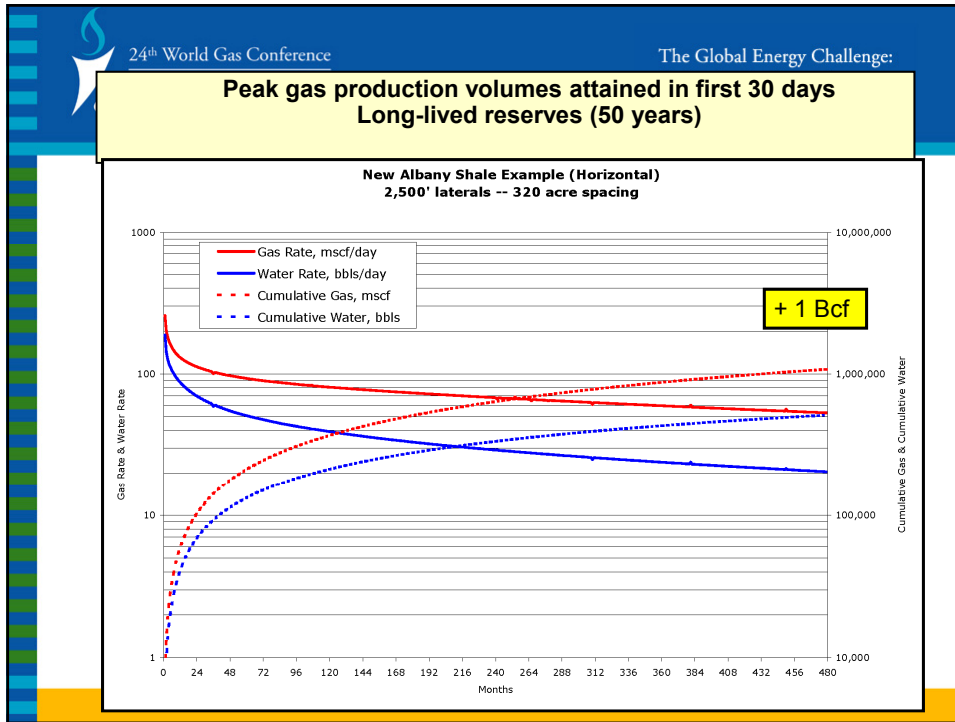


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**Surface Production Units
and Infrastructure**





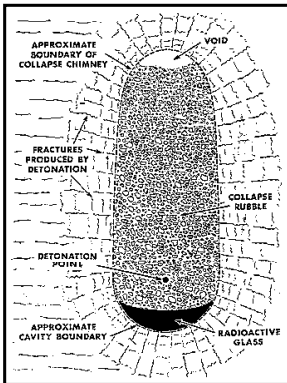
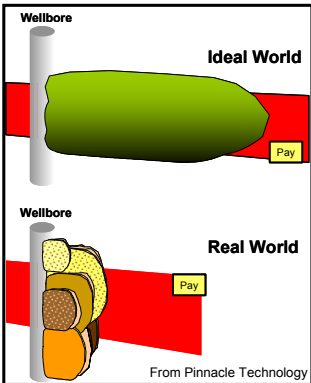

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Summary

- **The New Albany Shale contains vast reserves of natural gas, but technological challenges have posed a hindrance to economic development.**
- **Challenging Area with High Ultimate Potential**
 - Find Sweet Spots w/cost effective formula.
 - determine optimum well geometry.
 - optimum frac or no frac.
 - predict cumulative production from early production data.
 - control well costs.
 - understand and mitigate environmental issues, water management and footprint; disseminate all results.

History of Unconventional Gas Precision Replaces Horsepower

1960's	1980's	2000's
 <p style="font-size: small;">APPROXIMATE BOUNDARY OF COLLAPSE CHIMNEY VOID FRACTURES PRODUCED BY DETONATION COLLAPSE RUBBLE DETONATION PATCHES APPROXIMATE CAVITY BOUNDARY RADIOACTIVE GLASS</p> <p>Nuclear Stimulation</p>	 <p style="font-size: small;">Wellbore Ideal World Pay Wellbore Real World Pay From Pinnacle Technology</p> <p>Massive Hydraulic Fractures</p>	 <p>Microhole Wellbore Placement</p>