U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory
Strategic Center for Natural Gas and Oil

Technologies for Tomorrow's E&P Paradigms

Microhole Technology

Change your perspective

September 2004

Microhole Technologies

Reduce Drilling Costs and Environmental Impact

Increase Reservoir Imaging Resolution and Real-time Data Acquisition

DOE's Microhole Technology Initiative is developing technologies that enable Coiled Tubing Drilling of 3½-inch and less boreholes using small, portable coiled tubing drill rigs.

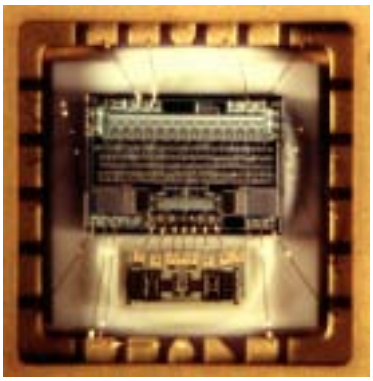
These new technologies will support business models for:

- Development of Shallow (5,000 ft) Currently Uneconomic Oil and Gas Resources (Current Solicitation focus).
  - Lower Drilling Costs result from reduced materials, labor and support equipment.
  - Lower Environmental Impact results from reduced drilling waste, smaller footprints, and increased transportability for remote, fragile terrains. Pad drilling allows extended wellbore reach without increased environmental risk.

Tom Gipson, New Force Energy Services

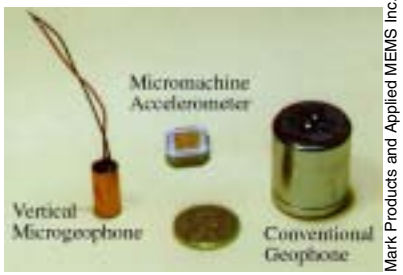
- New Economic Seismic Methodologies for Reservoir Imaging (Higher-risk work being conducted by the National Laboratories).
  - Decrease finding costs by proving exploration targets more economically.
  - High resolution real-time reservoir information from dedicated boreholes with permanently installed reservoir monitoring systems. Can monitor and optimize IOR processes for maximum recovery efficiency.
  - Control over data collection locations - "Designer Seismic" concept allows data to be collected where and when it is needed rather than where production/injection wells have been drilled.
  - Minimum interruption of production while collecting reservoir data.
  - Low cost, miniature instrumentation using MEMS (Microelectromechanical) technologies.

Microhole technologies are expected to:



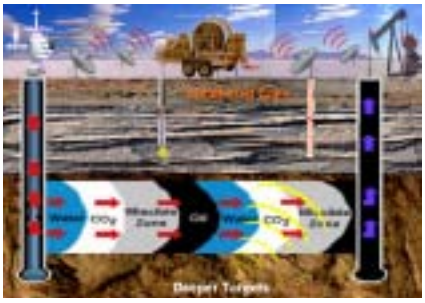
Silicon Designs

A microelectromechanical (MEMS) accelerometer.



Mark Products and Applied MEMS Inc.

Miniature seismic sensors now under development have a performance approaching that of conventional geophones.



Kinder Morgan

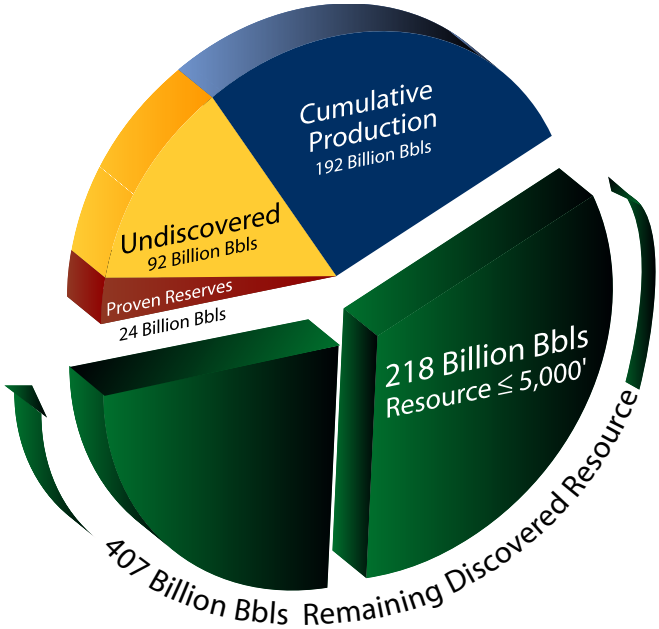
Permanent seismic reservoir monitoring allows imaging of a CO_2 flood.

- Enable independent producers to invest in a new wave of infill drilling of shallow development wells;
- Be an enabling technology for new high resolution seismic imaging utilizing Microelectromechanical Systems (MEMS) technologies. This technology program is expected to result in unprecedented seismic imaging using miniaturized sensors for:
  - Low impact, high resolution exploration methods for developing exploration targets.
  - Low cost, long term monitoring for improved imaging of fluids moving through the reservoir during Improved Oil Recovery (IOR) operations. This capability is expected to significantly enhance recovery of the 218 billion barrels of oil resource known to be less than 5,000' deep.
- Allow, for the first time, economical permanent reservoir monitoring that reduces interruption of production. This new-found geophysical capability utilizing Vertical Seismic Profiling (VSP) is referred to as "designer seismic" because, for the first time, the geophysicist will be able to pick the location of the instrument package rather than utilize an existing well for a short time while production is shut-in.
- Allow economical re-entry of existing wells to increase production from by-passed zones. It will also provide a reliable capability to deepen the thousands of boreholes across the U.S. with 4½-inch diameter casing set at bottom. This will encourage deeper exploration in existing fields because the top section of the hole has already been drilled.

why is it needed?

Only about one-quarter of technically recoverable domestic oil resources are considered economically recoverable even at today's high oil prices. The attraction of microhole drilling is the prospect of greatly reducing the cost of drilling shallow- and moderate-depth holes for exploration, field development, long-term subsurface monitoring, and to a limited degree, actual oil and gas production. If the costs of the activities can be reduced, oil and gas reservoirs that are uneconomic to produce today could become economically viable in the future.

The fact that microhole technologies reduce the costs of overall operations makes exploration and production of domestic resources economically attractive to the independent operators that produce most of the domestic oil. These new low cost production and reservoir monitoring capabilities are essential to developing a new E&P paradigm needed to invigorate the domestic oil and gas industry and enable it to recover significantly more of the petroleum resource in America's mature basins.



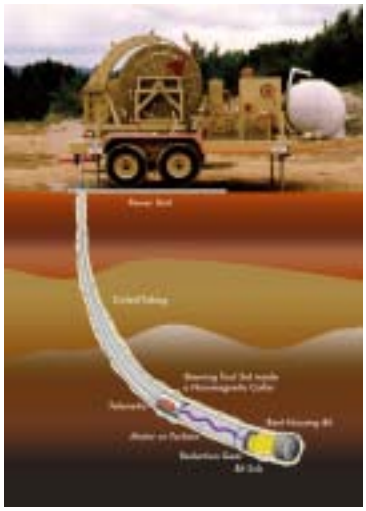
what are the expectations?

Microdrilling technologies along with micro-instrumentation are expected to provide low-cost wells for exploration, long-term reservoir monitoring, and increased production. Reduction in materials, labor, and support equipment all serve to reduce drilling costs by as much as one-half the cost of drilling a conventional well. Volumes of drilling fluids and cuttings could be lowered by one-fifth, reducing disposal costs. Smaller footprints and lower disposal volumes lower the environmental impact of drilling activities making microhole drilling applicable in environmentally sensitive areas. Overall coiled tubing drilling efficiency improvements are expected to be a carryover benefit from this program that may be applied in ultra-deep water offshore operations.

The economic and environmental benefits resulting from the MHT Program are expected to increase E&P activities thereby increasing domestic oil and gas production and revenues from Federal Lands. An additional 10% recovery of the remaining 218 billion barrels of oil from reservoirs less than 5,000' deep is a conservative estimate of the potential results of the MHT program – this represents 10 years of OPEC imports.

Microhole Solicitation I

The Microhole Initiative was based in part on miniaturization of seismic sensors, microhole rig development and feasibility studies conducted by Los Alamos National Laboratory (LANL) and their industry partners. The successful feasibility study and demonstration of coiled-tubing-deployed microdrilling provided a promising indication that microholes could assume an important role in increasing recovery from domestic oil and gas fields.



Los Alamos National Laboratory coiled tubing microdrilling unit used in field demonstration.

The first solicitation from the Microhole Initiative focused on field demonstrations and development of technologies needed to employ coiled-tubing microhole drilling in the field. Specific area addressed were:

Field Demonstration

Conduct demonstrations of existing 4¾-inch commercial microhole technology and applications in different regions of the United States.

Built for purpose Microhole Coiled Tubing Rig

Design Microhole Coiled Tubing Rigs that can drill 1-inch through 2⅜-inch coiled tubing bore holes with low density compressible drilling fluids.

Self-Contained "Zero-Discharge" Drilling Mud System

Develop mud systems that are truck, trailer or skid mounted that meet USDOT limitations. The mud system must be able to mix, circulate downhole, clean and hold diesel or water based drilling mud; and be compatible with an underbalanced drilling system.

Microhole Coiled Tubing Bottom Hole Assemblies

Develop Measurement While Drilling; Logging While Drilling; Directional Assemblies; and Positive Displacement Motors suitable for drilling 3-inch boreholes.

Microhole Completion and Production Equipment.

Develop completion and production equipment.

Microhole Solicitation I Awards

Baker Hughes

Baker Hughes 2⅜ inch CoilTrak™ coiled tubing drilling assembly. The project will develop a geosteering device and a resistivity module to add to this commercially available drilling assembly.

Baker Hughes Inteq, Houston, Texas

"Microhole Smart Steering and Logging While Drilling System"

Area: Bottom Hole Assemblies

The objectives of this project are to design and fabricate a drill bit steering device and a tool that measures the electrical resistivity of reservoir rock. Both the bit steering device and the motor will be 2-inch diameter to serve a 3½-inch or smaller hole size. The modules will be designed so they fit seamlessly in the already commercially available module 2⅜-inch CoilTrak™ a coiled tubing drilling assembly. These tools are expected to provide a modular and effective coiled tubing drilling system that enables higher, more effective production from existing domestic oil fields.

Bandera Petroleum Exploration, Tulsa, Oklahoma

"Advanced Mud System for Microhole Coiled Tubing Drilling"

Area: Self-Contained Zero Discharge Drilling Mud System

Bandera Petroleum

Bandera Petroleum Exploration will demonstrate a zero discharge drilling mud system.

The principal objective of this project is to develop a mud system compatible with coil tubing drilling of small diameter holes for vertical, horizontal, and multilateral drilling, in addition to completion applications. The mud system is expected to mix the required fluids, circulate that mixture downhole, clean and store the returned fluids, and be able to perform these functions with zero discharge and acceptable levels of environmental impact. The mud system is anticipated to operate at 15 gallons per minute and 5,000 psi; and 500 gallons per minute at 1000 psi and use standard oil field mud pumps.

Gas Production Specialists

Gas Production Specialists slimhole electric submersible motor.

Gas Production Specialties, Lafayette, Louisiana

"Development of Through Tubing (Microhole) Artificial Lift System"

Area: Completion and Production Equipment

The goal of this project is to develop a novel artificial lift system that can remove downhole fluids that hinder gas production. The lift system is expected to address problems of mature, low-pressure reservoirs that can't overcome the weight of the wellbore fluids thereby preventing gas production. The technology will allow operators, particularly those in the Gulf of Mexico, to reactivate wells that can no longer flow by natural reservoir pressures. This technology is expected to increase recovery from reservoirs whose natural pressure have been depleted by previous production.

Schlumberger

Example of a coiled tubing drilling rig currently used by Schlumberger. In this project a "built-for-purpose" microhole coiled tubing drilling rig will be developed and built that has a small footprint, is easy to move and fast to mobilize.

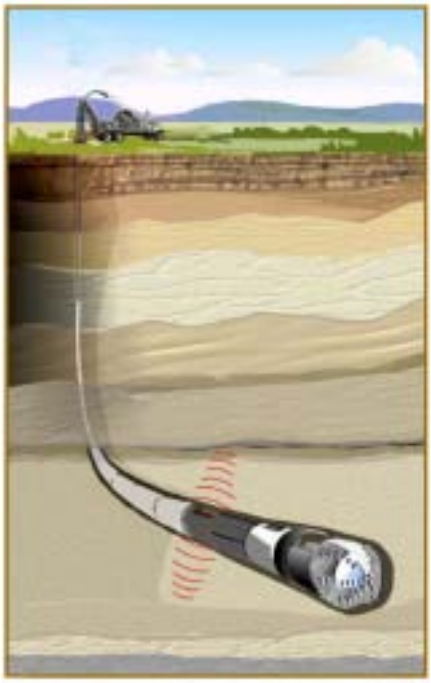
Schlumberger IPC, Sugarland, Texas

"A Built for Purpose Coiled Tubing Rig"

Area: Built for Purpose Microhole Coiled Tubing Rig

The focus of this project is to develop and build a microhole coiled tubing drilling rig that is designed specifically for the abundant shallow oil and gas reservoirs found in the lower 48 states. The rig will be designed to improve the economics of shallow well drilling by using small and purpose-built equipment that is easy to move and fast to mobilize, yet versatile in its application. The drilling rig will be designed to perform over- and underbalanced drilling work for both new and existing wells.

Stolar Research

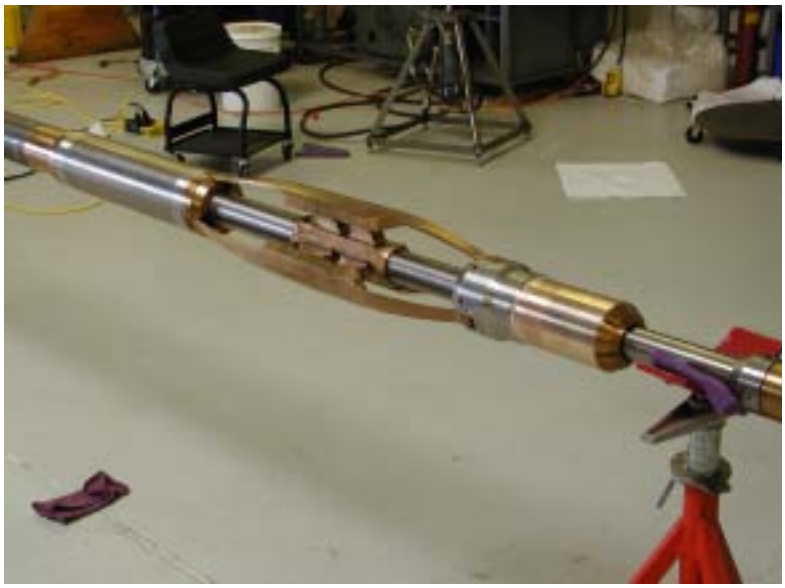


Radar-guided drilling system will be integrated with a coiled tubing bottom-hole assembly.

Stolar Research, Raton, New Mexico "Development of Radar Navigation and Radio Data Transmission for Microhole Coiled Tubing Bottom Hole Assemblies"

Area: Microhole Coiled Tubing Bottom Hole Assemblies

The objectives of this project are to develop technologies to guide the drill bit when drilling horizontal wells and transmit rock and fluid information to the surface as it is collected. Radar will be used to determine the location of the drill bit, and radio data transmission will be used to communicate the measurement data to the surface. Radar will be integrated with the coiled tubing bottomhole assembly and radio data transmission will be accomplished either directly along the coiled tubing or via an insulated slickline inside the coiled tubing to the surface.



Coiled tubing drilling tractor for drill bit transport in horizontal well sections.

Western Well Tool, Anaheim, California "Microhole Downhole Drilling Tractor"

Area: Microhole Coiled Tubing Bottom Hole Assemblies

The goal of this project is to design and build a reliable and economical hydraulically powered coil tubing drilling tractor that will transport the drill bit and measurement tools into long (>3,000 ft) sections of horizontal wells. The prototype drilling tractor will be field tested using a commercial coiled tubing rig at the Gas Research Institute drilling test site. Multiple re-entry, inclined and horizontal holes will be drilled.

Applications of
Microhole Technologies

To assure industry relevance of the Microhole Technologies Initiative, a group of oil and service company representatives met to discuss the merit, needs, potential development and applications of microhole technology. The group identified the following, potentially significant applications of microhole drilling using coiled-tubing.

Shallow Development wells

Advantages of drilling with coiled tubing microhole technology is that drilling requires about one-third the space and one-third the number of equipment loads when compared with a rotary drilling rig.

Reservoir & Seismic Data Holes

Small diameter dedicated wells can be used to monitor reservoir response to production and injected fluids. The wells will not disrupt production; and can be located at optimum locations to obtain 4-D images of reservoir fluid movement and bypassed oil.

Drilling Shallow Re-Entry Wells

Low-cost re-entry of existing wells allows drilling single or multiple lateral boreholes that allow “deep” perforations; imaging of lateral variations of reservoir properties by seismic array deployments, and vertical flooding projects that could significantly increase recovery especially from mature mid-continent fields and return them to profitable operations.

Drilling Deep Exploration Tails

Microhole re-entry to existing wells can cheaply extend the well bore to evaluate zones just below the targeted zone of interest.

Get On Board.

A Team Building Data Sheet is provided to facilitate cooperation among technology developers, providers, and producers interested in working together on microhole technology development and/or demonstration.

If you have a technology or producing property you would like to contribute to a field demonstration of microhole technologies, fill out the form on the opposite page and mail or fax to Paul West, Project Manager, One West Third Street, Suite 1400, Tulsa, OK 74103. Fax: 918-699-2005.

The form can also be found at:

http://www.netl.doe.gov/scngo/petroleum/index.html
Then click on Long-Term Research Efforts, click Microhole Technologies Initiative, click Teaming Signup, click Team Building Form to enter your data. Email the form to microhole@netl.doe.gov.

Information submitted on this form will be made publicly available on the Team Building Data sheet.

MICROHOLE TECHNOLOGIES TEAMING INTEREST PARTICIPANTS

	Contact Name	Company Name	Email	Phone	Fax	Teaming Interest
Existing Technology Provider						
CT Rig						
Downhole Tools						
Mud/Closed UBD Circ. System						
Completion/Production Tools						
New Technology Developer						
CT Rig						
Downhole Tools						
Mud/Closed UBD Circ. System						
Completion/Production Tools						
Producer						
50% Cost Share Provider						
Demonstration Site Provider						

Microhole Technologies

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Check out our website at
www.netl.doe.gov/business
for new project funding solicitations

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