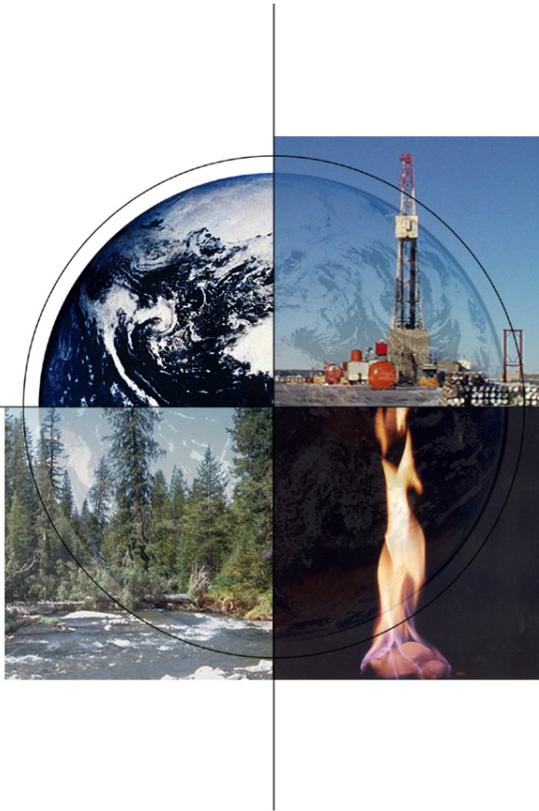


US Dept of Energy Oil & Gas Research



Brad Tomer

*Director, Strategic Center for
Natural Gas & Oil*

*EPACT Section 999 Federal
Advisory Committee Meetings*

January 28-29, 2008

National Energy Technology Laboratory

Office of Fossil Energy



Strategic Center for Natural Gas & Oil

Implement science and technology programs that resolve the environmental, supply and reliability constraints of oil and natural gas resources and enhance our energy security



- **Create public benefits by investing in research that industry would not take on itself**
- **Deliver a balanced portfolio of technology to:**
 - Enable Independents to efficiently produce discovered resources
 - Conduct long-term/high risk R&D - develop entirely new sources of supply
 - Minimize environmental impact

A multi-discipline, long-term, high-risk, and high-reward endeavor that will only occur through Federal involvement.



NETL Program Implementation

Partnership Approach

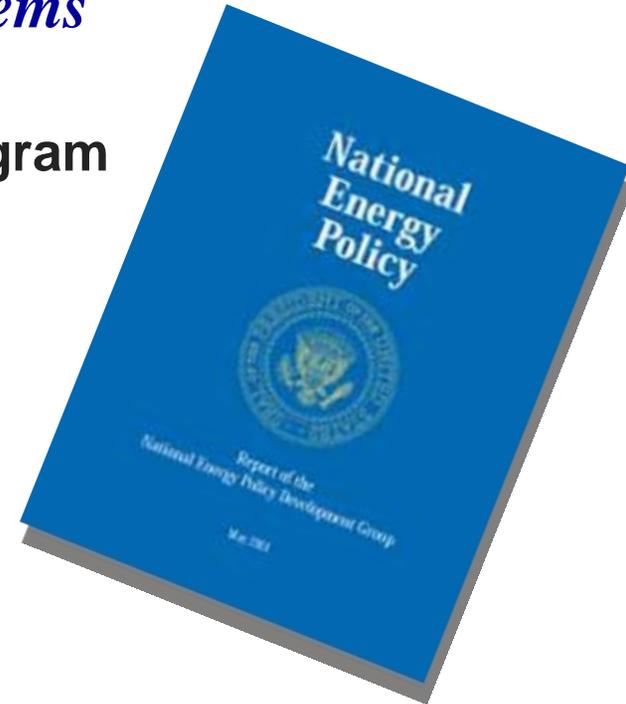
- **Careful planning with significant industry input**
 - Technology roadmaps, advisory committees, consortiums, peer reviews
- **Cost-shared R&D conducted with partners**
 - Industry, federal agencies, national labs, universities
- **On-site research subjected to annual merit review**
- **Robust technology transfer**
 - Successful field demonstrations, PTTC, website, workshops, GasTIPS



Energy Policy Act of 2005

DOE Oil & Gas RD&D Items

- **Sec 965 - DOE Traditional Oil and Gas Program**
 - DOE conduct a program of Oil & Gas RD&D
 - E&P; oil shale; environmental
- **Sec 968 – Methane Hydrate Research**
 - DOE-led multi-agency program
 - Resource, safety, environmental impacts
- **Sec 999 – Ultra-deepwater & Unconventional Program**
 - Royalty trust fund (\$50 million/year for 10 years)
 - Consortium for ultra-deep water; unconventional; small producers
 - Complementary research at NETL



NETL Natural Gas & Oil Program

Comprehensive R&D Portfolio



*Exploration &
Production*



*Arctic Energy
Office*



*Methane
Hydrates*



*Petroleum
Environmental
Solutions*



*EPACT 2005
Sec. 999*



Natural Gas & Oil Technology Programs

Budget (\$ million)

	FY05	FY06	FY07	FY08*
Exploration and Production	23.0	17.8	0	0
Gas Hydrates	9.1	8.9	12.0	15
Effective Environmental Protection	3.4	1.5	0	5
TOTAL – NATURAL GAS	43.6	32.7	12.0	20.0
Exploration and Production	18.2	13.4	2.7	5
Reservoir Life Extension	5.8	5.9	0	0
Effective Environmental Protection	9.0	9.5	0	0
TOTAL - OIL	33.0	31.7	2.7	5
TOTAL – TRADITIONAL PROGRAM	76.6	64.4	14.7	25
EPACT Section 999 Consortium			37.5	37.5
EPACT Section 999 Complementary			12.5	12.5
TOTAL – EPACT Section 999			50	50
TOTAL – NATURAL GAS AND OIL	76.6	64.4	64.7	75



**Omnibus*

Natural Gas & Oil Technology Programs

Congressionally Directed Projects (\$ million)

	FY08*
<i>Stripper Well Consortium</i>	1.5
Arctic Energy Office	7.0
Gulf of Mexico Gas Hydrates	1.0
Membrane Technology for Produced Water	1.5
Interdisciplinary Clean Energy Program	1.75**
Gulf Petro Initiative	.75
TOTAL – Congressionally Directed Projects	13.5
Advanced Research	
LNG Test/Analysis/Report	8.0

**Omnibus*

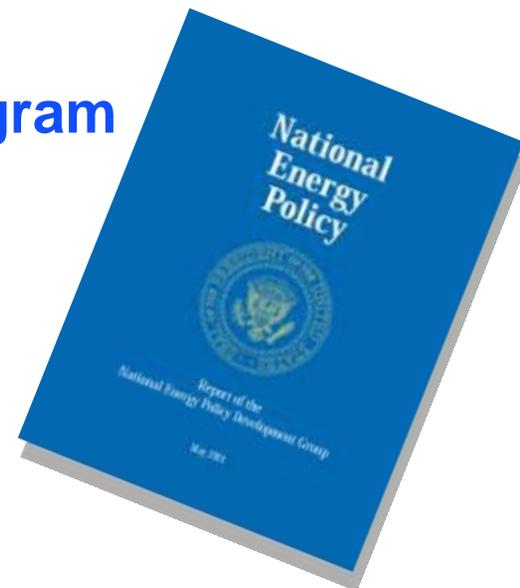
***1/2 of total*



Energy Policy Act of 2005

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Oil and Natural Gas E&P

Focus in 2008

- **Stripper Well Consortium**

- Reduce premature well abandonment



- **Petroleum Technology Transfer Council**

- Assure full utilization of technologies

- **Enhanced Oil Recovery**

- Modify CO₂ rheology
- Modeling flood performance
- Field demonstrations



Stripper Well Consortium



- Industry-driven consortium est. Oct 2000
- Funded by NETL, NYSERDA, members (65)
- SWC - \$8.3 million Cost Share - \$6.1 million
- 80 projects funded with >10% resulted in commercialized product
 - Hydraulic Diaphragm Electric Submersible Pump
 - Vortex Flow Tools
 - G.O.A.L. PetroPump
 - Downhole Wireless Gauge
 - Produced Water Desalination Unit
 - Pumper/Well Tender PDA Program
- **Technology transfer and outreach**
 - Brochure and 30-minute PBS program outline role of independents and stripper well production in U.S. energy mix



www.energy.psu.edu/swc

CO₂ Enhanced Oil Recovery R&D Program

Themes for Widespread Commercialization

- **Develop “Next Generation” Technologies**
 - High volume injection of CO₂
 - Innovative well designs/well placement
 - Effective mobility control agents
 - Gravity stable flooding
 - Performance diagnostics (e.g., 4-D seismic)
- **Demonstrate CO₂ EOR in New Areas**
 - Reduce risk for small independent producers
- **Develop Synergies with Clean Coal Program - Potential Low-Cost Sources of CO₂ (e.g. power companies)**



CO₂ EOR Demonstration at Citronelle Field

University of Alabama at Birmingham

Objective:

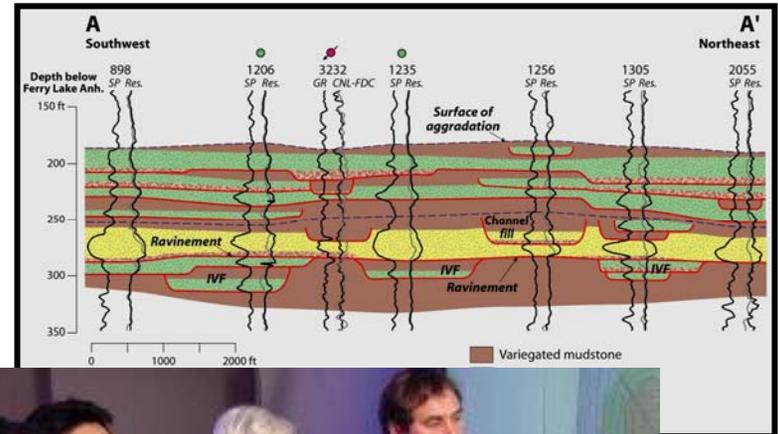
Conduct reservoir simulation and other testing at the Citronelle Field to enable implementation of state-of-art CO₂ EOR project by independent producer

Accomplishments:

Geologic characterization has been initiated and supplier has committed to supplying CO₂ for planned pilot

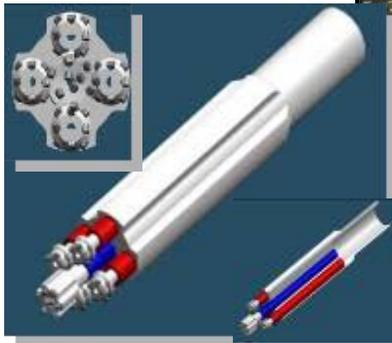
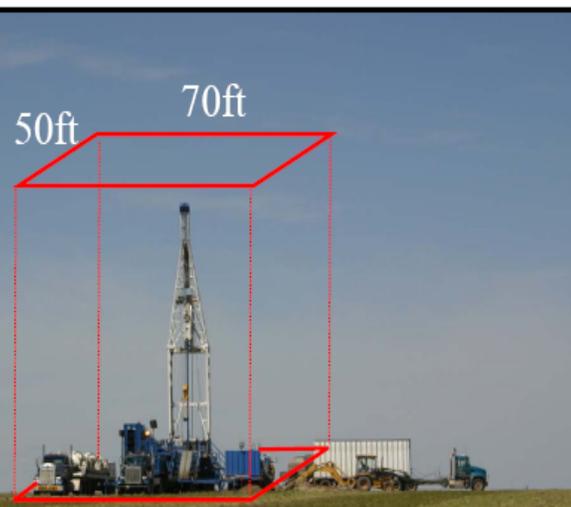
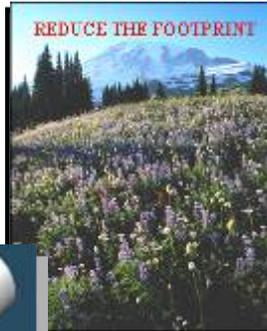
Benefits:

If successful, this demonstration of state-of-art CO₂ EOR will facilitate expansion of CO₂ EOR operations in Mississippi into new reservoirs in Alabama, and provide a demonstration of CO₂ sequestration potential



Coiled Tubing Drilling for Advanced EOR

An Integrated System of Tools, Instruments, & Equipment



Counter Rotating Tandem Motor

Smart Steering/LWD



CTD Expandable Tubulars



Downhole Electronics

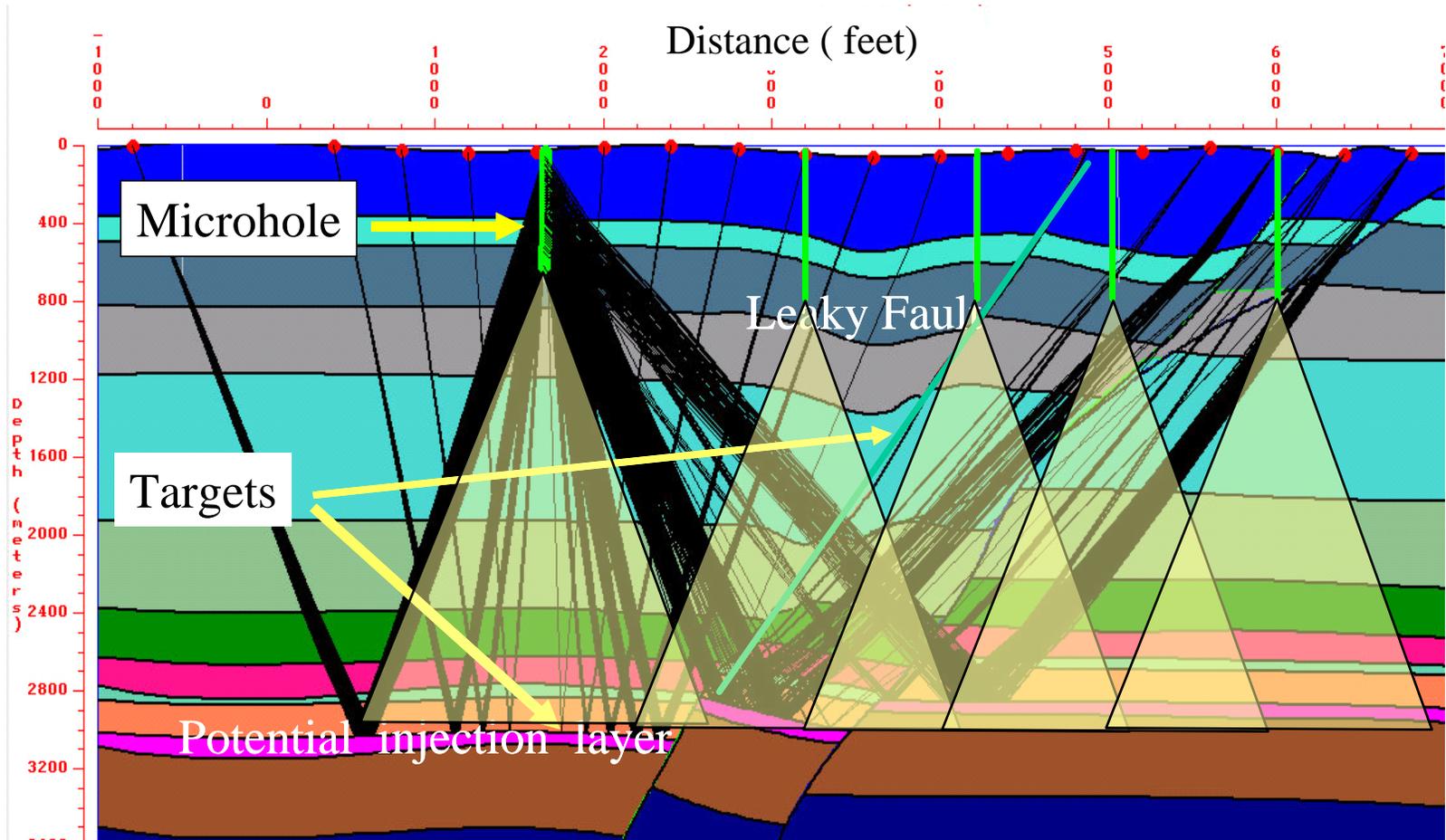


Wellbore Tractor

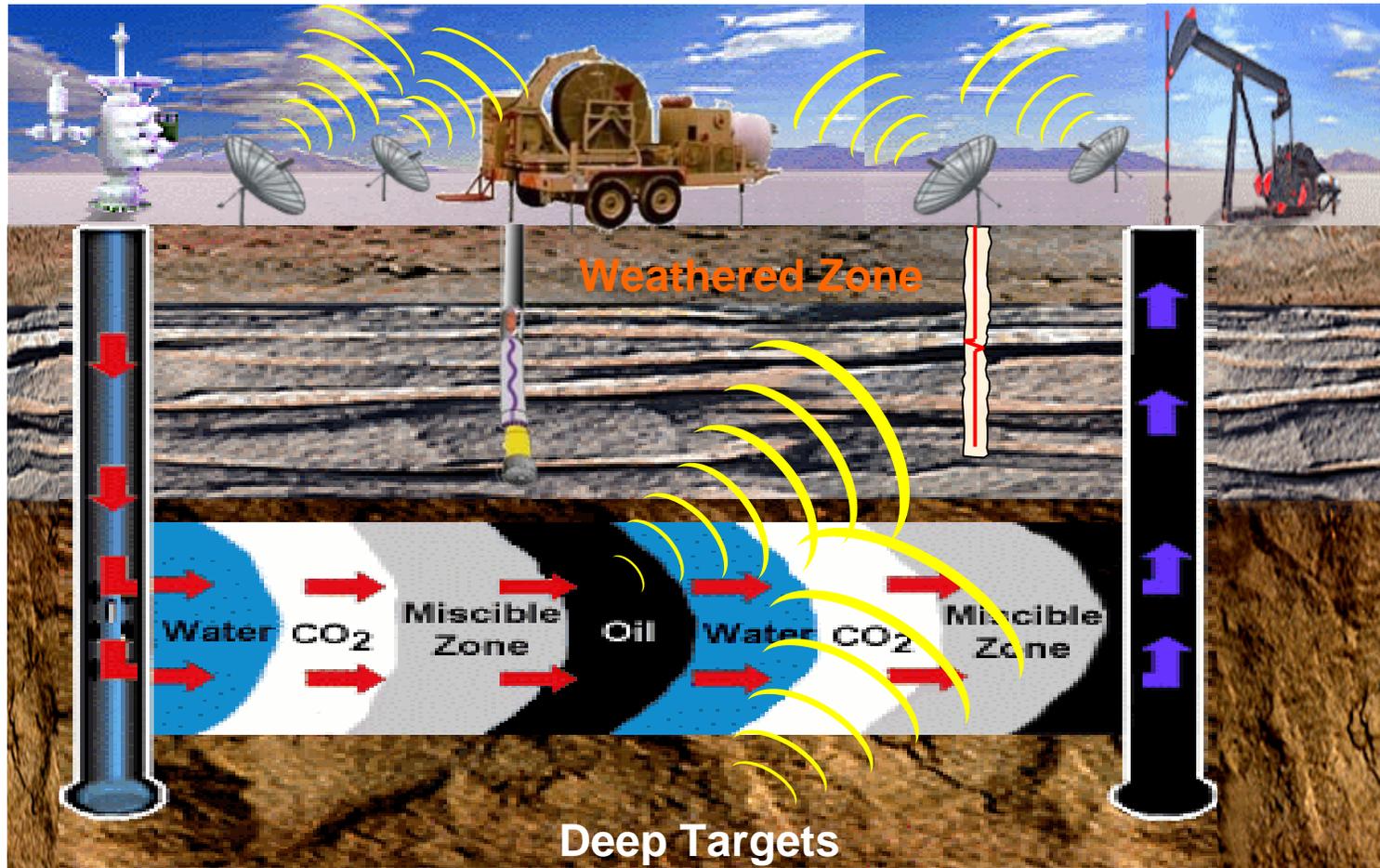


“Designer Seismic”

Revolutionary Approach to High Resolution Seismic Imaging



Reservoir Monitoring Using VSP Microhole Technology



Note: Modified from Kinder Morgan CO₂ LP Company

Strategic Center for Natural Gas and Oil

Microhole/VSP Imaging for CO₂ EOR

LANL/LBNL (*Whiting Petroleum*)

Objective

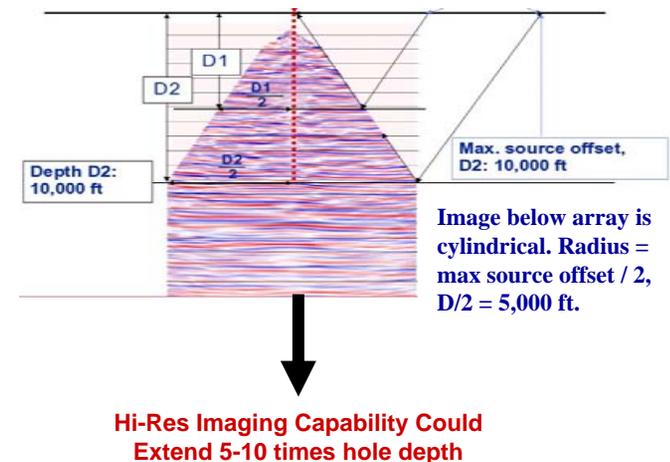
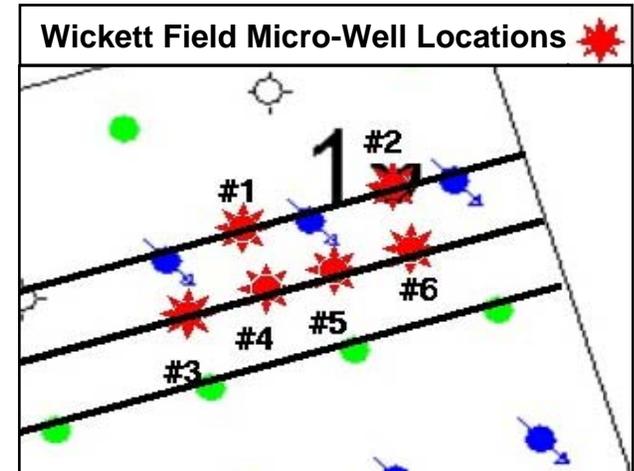
- Demonstrate “downward looking” VSP for CO₂ EOR pilot monitoring

Accomplishments

- First seismic data acquisition R&D in over 20 years
- Drilled 5 seismic instrumentation holes in new CO₂ pilot
- Demonstrated capability of microseismic monitoring system monitoring local events
- First survey results, Sep 2007
- Survey to monitor CO₂ pilot continues

Benefits

- Lower cost, higher resolution imaging for complex reservoirs and EOR monitoring



Coiled Tubing (CT) Drilling

- **Objective: Develop coiled tubing drilling technologies to extend application, lower costs & decrease impact**
- **Significant accomplishments:**
 - Hybrid CT rig drilled 25 Niobrara wells; 25-38% cost savings; 1 Tcf now economic (GTI)
 - Developed CT tractor that extends horizontal capability by 50%; field tests in Alaska underway (Western Well Tool)
 - Developed “smart” CT steering and logging system; commercialized, to be applied in Kuparuk (Baker Hughes INTEQ)
 - Developed faster CT rig; now active in Barnett Shale helping to add 45 Tcf of unconventional gas reserves (Schlumberger)
 - Potential for using CT drilled shallow wells to apply vertical seismic profiles to monitor EOR

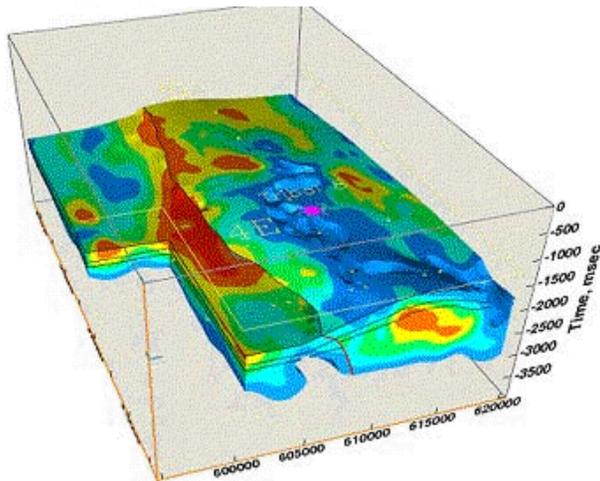


Oil and Gas Exploration & Production

Drawing to a Successful Close

- **Advanced Diagnostics & Imaging**

- Improved characterization
- Advanced seismic for natural fracture detection and EOR (4D)



- **Drilling, Completion & Stimulation**

- Increase rate of penetration
- More durable tools
- Innovative concepts
- DeepTrek



Hydraulic Fracture Mapping

Pinnacle Technologies

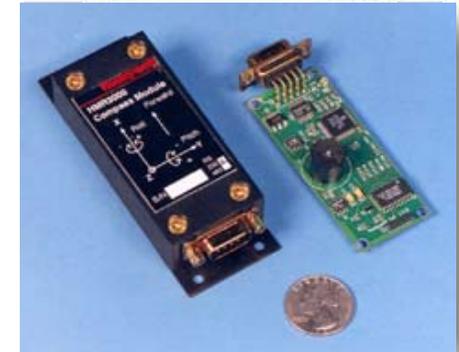
- **Objective: Develop and test an advanced hydraulic fracture mapping system with improved instrumentation that combines seismic sensors and tiltmeters in one tool**
- **Accomplishments include:**
 - Completed field test of combined microseismic mapping (geophone)/tiltmeter
 - Good data sets gathered and tool survived hydraulic frac treatment while placed in treatment well.
 - Performed long term test in San Andreas Fault Observatory at Depth (SAFOD) well
 - Technology commercialized (2007)
- **Single observation well reduces costs**
- **Extends capability of the most advanced technology for optimizing hydraulic fractures**
- **Will help optimize recovery from unconventional resources critical to meeting gas demand**



Deep Trek Program

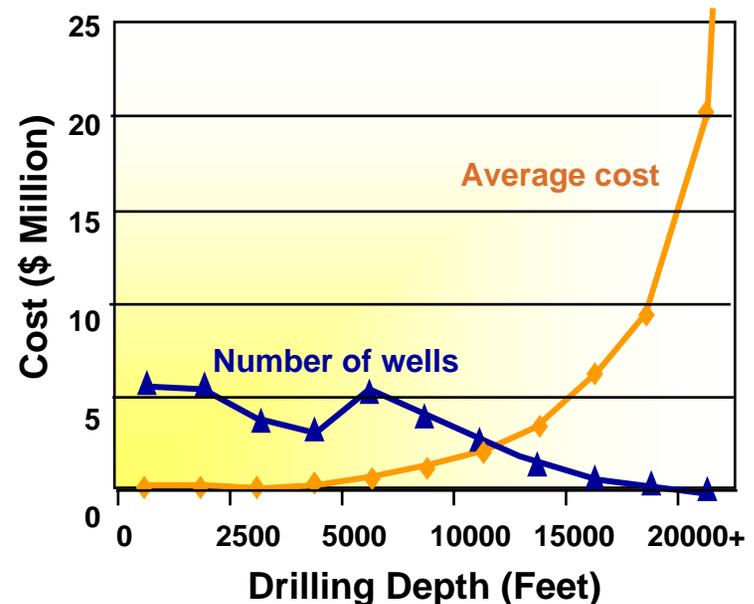
Tools for Extreme Environments

- **Objective: Develop tools and technologies to enable drilling in hard rock and extreme (HT/HP) environments**
- **Program launched with Workshop in March 2001 and project awards followed in 2002-03-05-06**
- **Significant accomplishments:**
 - HT electronics (Honeywell, OSU)
 - HT/HP MWD (Schlumberger)
 - Super cement* (CSI Technologies)
 - Downhole vibration monitoring & control (APS Technology)
 - Deep EM telemetry (E-Spectrum)**
 - Other technologies underway: *
 - HT Battery and downhole turbine generator



***Meritorious Engineering Award at 2007 OTC**

****Comercialized in 2007**



Oil and Gas Environmental Program Focus for 2008

Energy/Environment intersection is most important issue of our time
Need technology/policy solutions that protect environment & increase production

- **Regulatory Framework**
 - Science-based stipulations
- **Unconventional Gas/Oil**
 - Water treatment/handling technology
 - Waste stream reduction technology
- **Low Impact E&P**
 - Desert Southwest
 - Arctic Tundra
 - Land use conflict areas



DOE Success: Membrane Filtration Technology for Treatment of Produced Water

Texas Engineering Experiment Station

Goal

- Develop portable reverse osmosis membrane filtration technology for produced water

Accomplishments

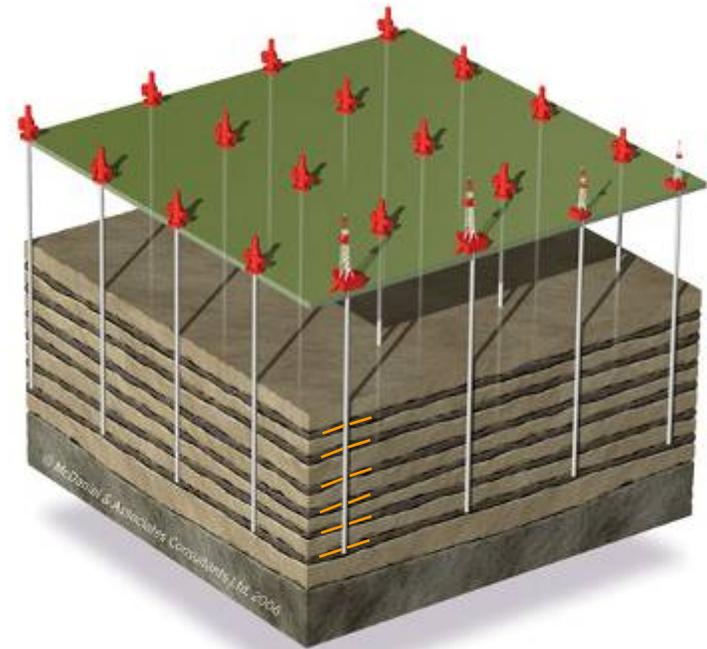
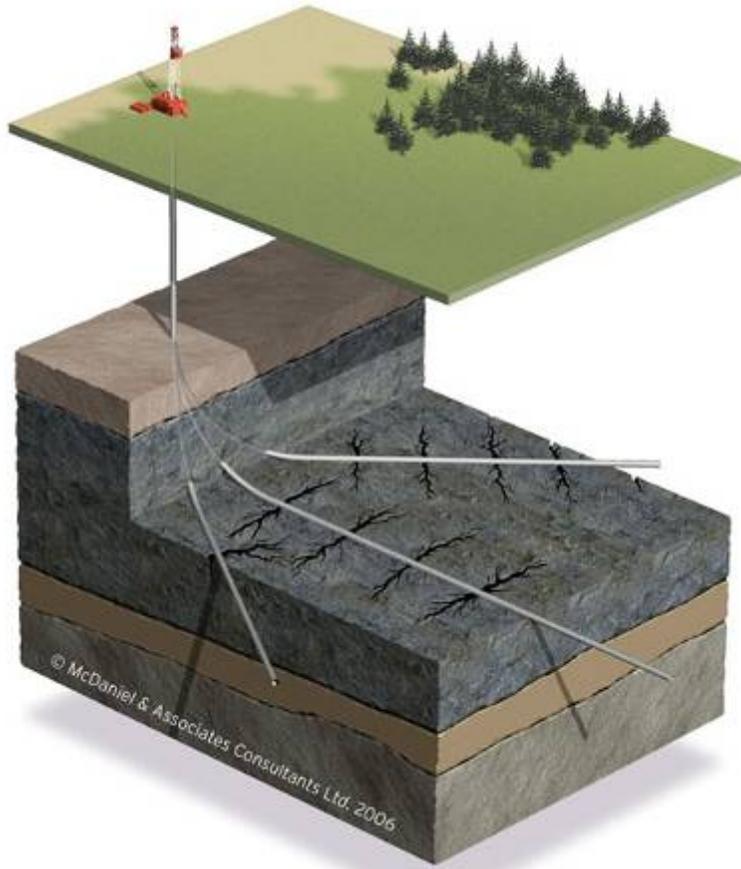
- The desalination technology has been commercialized through GeoPure Water Technologies.
- System will process 20 gallons per minute of feed water

Benefits

- Reduces disposal costs by 75%
- Provides fresh water for beneficial use



Coalbed Methane Completion-Production *Technology Advancements Yielding Tangible Benefits*

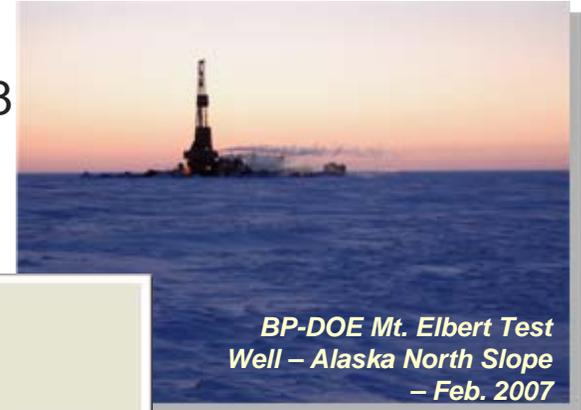


Methane Hydrates

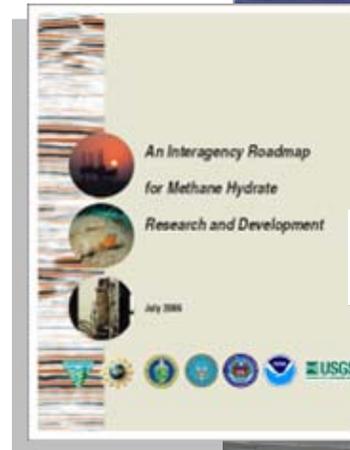
- **DOE-led interagency program**
 - Five-year authorization by EPACT 2005 Sec 968
 - Seven collaborating agencies
- **Huge potential resources**
 - 200,000 Tcf domestic gas-in-place

*If 1% can be rendered economic
will double nation's supply of gas*

- **Program addresses**
 - Safety & seafloor stability
 - Global climate impacts
 - Future Resource Potential
- **Impacts**
 - Better informed ocean/climate policy
 - Potential new domestic gas resource
 - Global realignment of energy supply



*BP-DOE Mt. Elbert Test
Well – Alaska North Slope
– Feb. 2007*



PUBLIC LAW 106-193—MAY 2, 2000
METHANE HYDRATE RESEARCH AND
DEVELOPMENT ACT OF 2000



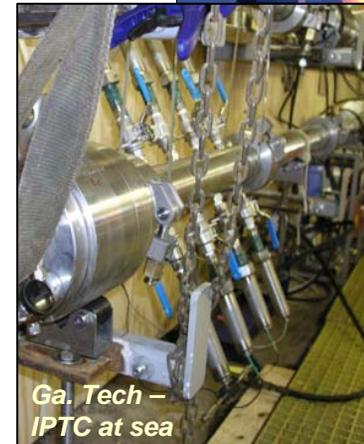
*NETL and USGS scientists
collaborate on India
Expedition – Aug. 2006*



The Program Up to Now

Setting the stage for current field activities

- Initiated development of numerical models (*LBNL, NETL*)
- Created laboratory capability to create proxy samples and study them (*USGS, ORNL, NETL*)
- Enabled development of current suite of standard sampling tools (*IODP, PNNL*)
- Demonstrated technical recoverability (*Mallik, BP*)
- Addressed industry safety issues in the Gulf (*Gulf of Mexico JIP*)
- Confirmed arctic resource potential (590 TCF ANS w/33 TCF under current infrastructure) (*BP, USGS*)
- Developed arctic and marine remote sensing capabilities (*USGS, BP, Stanford, WesternGeco*)
- Established fellowship program. Supported 150+ students in *at more than 30 institutions nationwide*
- Established extensive international collaborations





The Program Now

NETL's Gas Hydrate R&D effort

- **Marine: Multi-site drilling and coring program**
 - Log in FY2008, core in FY2009?
 - Test alternative GH exploration concepts/technologies
 - inform MMS assessment of potentially recoverable
- **Arctic: Long-term production testing with environmental monitoring**
 - Prudhoe Bay project (BP): Class 3 reservoirs
 - North Slope Borough (this spring): Class 1 reservoirs?
- **Technology Development/Modeling**
 - Field sampling and analysis tools
 - Numerical models (molecular to field scale) integrated w/ controlled lab experimentation
 - NETL-led modeling consortium
 - Exploration & production systems
- **International Collaboration**
 - Japan recent proposal for extensive collaboration
 - India, China & Korea: NETL ORD personnel direct support.

Gulf of Mexico

Joint Industry Project

- **Broad Consortium**
 - Government (*DOE, USGS, MMS*)
 - Industry (*Chevron, CP, Schlumberger, Halliburton, AOA geophysics*)
 - Academia (*Rice, Ga. Tech, Scripps*)
 - International (*KNOC (Korea), Reliance (India), JOGMEC (Japan)*) and expanding
- **Technology Developments**
 - Exploration technologies
 - Coring and core analysis equipment
- **Spring 2005 Expedition: Drilling Safety**
 - Typical GoM fine-grained sediments
 - Determined that GH risks are known/manageable
- **Spring 2008 Expedition: Resource issues**
 - GH-bearing reservoir sands
 - Test alternative exploration models
 - Support ongoing MMS GoM GH assessment





*Doyon 14 Rig at DOE-BP
Gas Hydrates test well,
Milne Pt. Alaska,
February, 2007*



DOE-BP Mt. Elbert Test Well

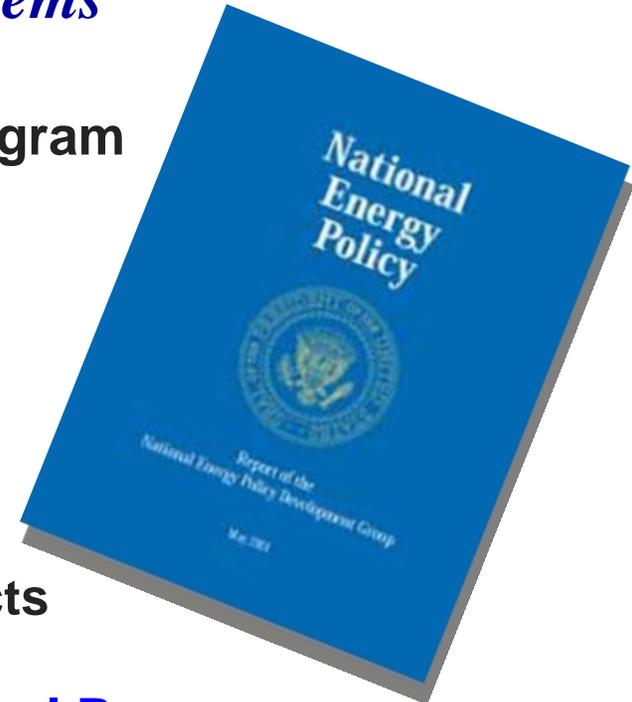
January, 2007

- Delineated first drillable GH prospects
- Produced first estimates of the technically recoverable resource from a GH prospect (up to 12 Tcf under Prudhoe Bay region alone)
- Demonstrated ability to safely collect data in shallow unconsolidated sediments
- Drilling confirmed exploration method – regional resource assessment
- Conducted first open-hole pressure test that confirmed gas release and technical producibility
- Acquired the most complete dataset available to the science community
- Cost: only ~\$4.2 M (Mallik = \$60 M)
- Set the stage for long-term production test in FY2009?

Energy Policy Act of 2005

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 - Royalty trust fund (\$50 million/year)
 - Consortium for ultra-deep water; unconventional; small producers
 - Complementary research at NETL



EPACT 2005, Subtitle J, Section 999

- Contract Awarded to RPSEA January 4, 2007
- Annual Plan Approved August 1
- **Received Funding in Sept/Nov 2007**
- **RPSEA (\$37.5 Million)**
 - Ultra-deepwater
 - Unconventional Gas
 - Technologies for Small Producers
 - NETL Management
- **NETL Complementary R&D (\$12.5 Million)**
 - Extreme Drilling (HT/HP)
 - Unconventional Oil and EOR
 - Environmental
 - Resource Assessment
 - Systems Analysis



Status of Solicitations

Released 10/17/07 Closed 12/3/07

- **Small Producer Program (review mtg. 1/11/08)**
- **Unconventional Onshore Resources (review mtg. 1/23/08)**

Released 11/5/07 Closed 12/27/07

- **Multiphase Meters: Deepwater Subsea Measurement**
- **Graduate Student Design Projects**
- **Effect of Global Warming on Hurricane Activity**
- **Deep Sea Hybrid Power System (Phase 1)**

Released 11/28/07 Closed 1/28/08

- **Carbon Fiber HP Riser Qualification Program**
- **UDW Dry Tree System (Phase 1)**
- **Fatigue Performance of High Strength Riser Materials**
- **Grand Challenge – Extreme Reach Development**
- **Synthetic Benchmark Models of Complex Salt**



Consortium Accomplishments

(July 2007 thru January 2008)

- **Developed Project Solicitation Process - Approved 10/5/07**
- **Developed Property Management System - Approved 11/30/07**
- **Administered Small Producer RFP - Solicitation released, Closed, Proposals reviewed, Selection meeting held**
- **Administered Unconventional Onshore Resources RFP – Solicitation released, Closed, Proposals reviewed, Selection meeting held**
- **Administering Ultra-deepwater RFPs - 9 released, 4 closed**
- **Delivered presentation at the Deep Offshore Technology 2007 conference in Norway in October 2007**
- **Developed and submitted recommendations to NETL for the draft 2008 Annual Plan**



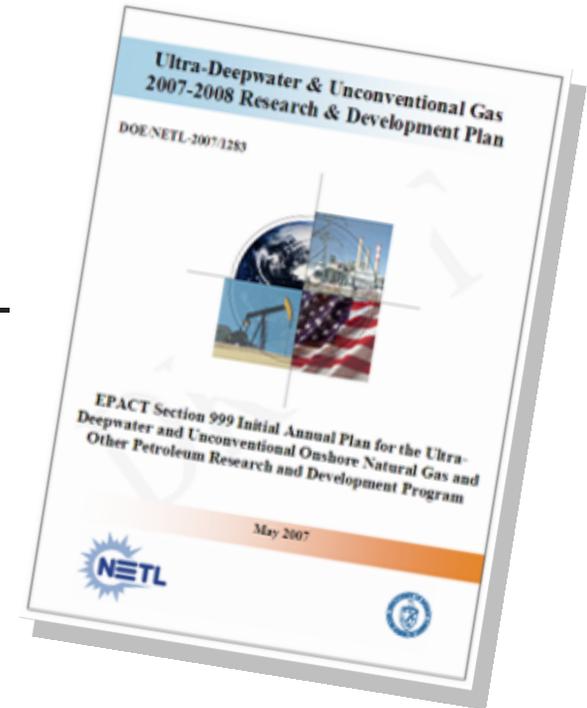
Consortium Plans for Early 2008

- Complete selection process for 2007 Solicitations
- Negotiate contracts and begin R&D
- Carry out additional Small Producers and Unconventional Resources solicitations to fill in gaps identified from 2007 Solicitations
- Continue on the track set by the 2007 Plan with fine tuning in 08 (2007 Plan was essentially a planning document for first two years of funding)



NETL Complementary R&D *Program Philosophy*

- Conduct unique, high-value, non-duplicative work under EPACT Section 999
- Coordinate with RPSEA & traditional program
- Focus:
 - Fundamental science
 - Long-term research providing basis for next-generation technologies
 - Unbiased environmental science
- Technical areas:
 - Drilling under extreme conditions
 - Environmental impacts of oil & gas development
 - Enhanced & unconventional oil recovery
 - Oil & gas resource & technology assessment
- Conduct annual merit review



Current Natural Gas and Oil R&D Funding

Managing and implementing a robust program

Department of Energy
Office of Fossil Energy

NETL

\$37.5

Appropriated Funds; \$46.5 (FY08)

Consortium Program

- ♦ Ultra-deepwater \$14.96
- ♦ Unconventional Gas \$13.85
- ♦ Small Producer \$3.21
- ♦ RPSEA administration \$3.56
- ♦ NETL oversight \$1.88

\$12.5

Complementary Program

- ♦ Extreme Drilling
- ♦ Unconventional Oil and EOR
- ♦ Environmental
- ♦ Resource Assessment
- ♦ Systems Analysis

Traditional Program

- ♦ E&P
- ♦ Hydrates
- ♦ Environmental
- ♦ EOR
- ♦ LNG

\$ → (millions)



FY08 Activities Summary

- Gas hydrates solicitation
- EOR & environmental solicitation
- Implement congressionally directed projects
- Management/oversight of program consortium
- Complementary program execution
- Completion of prior year(s) R&D



For Additional Information

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Brad.tomer@netl.doe.gov



NETL

www.netl.doe.gov



Office of Fossil Energy
www.fe.doe.gov



Strategic Center for Natural Gas and Oil

Extra Slides



Liquefied Natural Gas

FY08 Tests and Analysis

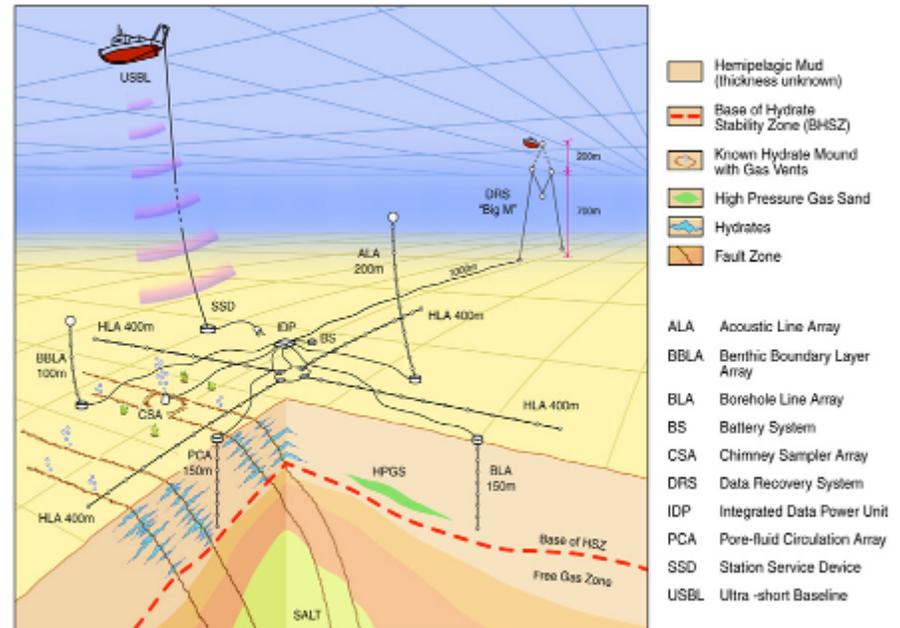
- Fossil energy engaging Sandia National Laboratory
- Key activities
 - Large scale pool fire
 - 40, 70, 100 meter diameter pools
 - Intensive data collection effort, e.g., thermal flux
 - Cascading effects analysis
- FY08 funding of \$8,000K
- Peer review
- Multiyear effort
- Updating costs, schedule, and milestones



Gulf of Mexico Sea Floor Observatory

U. Mississippi FY2008 Congressionally Directed

- **Passive monitoring system in Mississippi Canyon Block 818**
- **Observe response of sediment/gas/hydrate to environmental changes**
- **World class surficial gas hydrate system with active gas venting**
- **Work remaining**
 - To characterize deep sediment structure- GH occurrence
 - Complete deployment of geophysical arrays
 - Long-term testing of geochemical arrays
 - Establish fibre-optic data connections



Gas Hydrate Sea Floor Observatory - Mississippi Canyon Block 118

