CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

CURRENT STATE OF THE GULF OF MEXICO

GAS HYDRATE MONITORING STATION PROJECT

SEPTEMBER, 2003

Prepared by
The Center for Marine Resources and Environmental Technology
of
The University of Mississippi

The University of Mississippi

CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

OBJECTIVE OF THE PROJECT

To establish a remote, multisensor monitoring station

at a selected location within the hydrate stability zone

of the northern Gulf of Mexico

The University of Mississippi

GAS HYDRATE MONITORING STATION SCIENTIFIC SUPERVISORY BOARD

Managing Director: Bob Woolsey, Center for Marine Resources and Environmental Technology, University of Mississippi, Oxford, MS.

Geologic Setting: Harry Roberts, Coastal Studies Institute, Louisiana State University, Baton Rouge, LA.

Vertical Line Arrays: Ross Chapman, School of Earth and Ocean Sciences, University of Victoria, British Columbia, Canada

Vertical Seismic Profile: Bob Hardage, Bureau of Economic Geology, University of Texas, Austin TX

Water Currents: Vernon Asper, Institute of Marine Sciences, University of Southern Mississippi, Ocean Springs, MS.

Gas Bubble Studies: Ralph Goodman, Applied Research Laboratory, Pennsylvania State University, University Park, PA.

Geoelectric Systems: Rob Evans, Woods Hole Oceanographic Institution, Woods Hole, MA.

Geochemistry: Roger Sassen, Geochemical and Environmental Research Group, Texas A&M University, College Station, TX.

Geotechnical Studies: Angela Davis, School Of Ocean Sciences, University of Wales (Bangor), Menai Bridge, Anglesey, Bangor, Wales, U.k.

Water Chemistry: Jean Whelan, Woods Hole Oceanographic Institute, Woods Hole, MA.

Pore Water Chemistry: Jeff Chanton, Department of Oceanography, Florida State University, Tallahassee, FL.

Laboratory Studies: Rudy Rogers, Chemical Engineering Department, Mississippi State University, Starkville, MS.

Heat Flow Studies: Bernie Bernard, TDI-Brooks International Inc., College Station, TX.

Pharmaceuticals: Marc Slattery, Pharmacognosy Department, University of Mississippi, Oxford, MS.

Comparative Studies: Camelia Knapp, Department of Geological Sciences, University of South Carolina, Columbia, SC.

Data Recovery: Paul Higley, Specialty Devices Inc., Plano, TX.

Site Surveys: Tom McGee, CMRET, University of Mississippi, Oxford, MS.

CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

BRIEF OVERVIEW OF FY 2002/03

During FY 2002/03, significant progress was made in several aspects of the research activities leading to installation of the gas hydrate monitoring station.

These aspects included:
building and testing equipment,
deploying equipment at sea,
and laboratory experiments.

Several involved use of the Johnson Sea Link manned submersible.

All were funded by DOE-NETL and/or MMS-Herndon.

The University of Mississippi

CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

BASIS OF CONCERN

**At certain locations in the Gulf of Mexico,
evidence of hydrocarbon seeps on the sea floor
is visible as oil slicks on the sea surface
because oil rides up on gas bubbles,
some of which may originate from
the dissociation of natural gas hydrates.**

The University of Mississippi

CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

Natural gas hydrates occur on the sea floor of the Gulf of Mexico in outcropping mounds that also contain other minerals such as carbonates that have been precipitated by microbial activity.

Temperature probes were inserted in one such mound and in the mud nearby by researchers from Texas A&M University and TDI-Brooks International, Inc.

The University of Mississippi

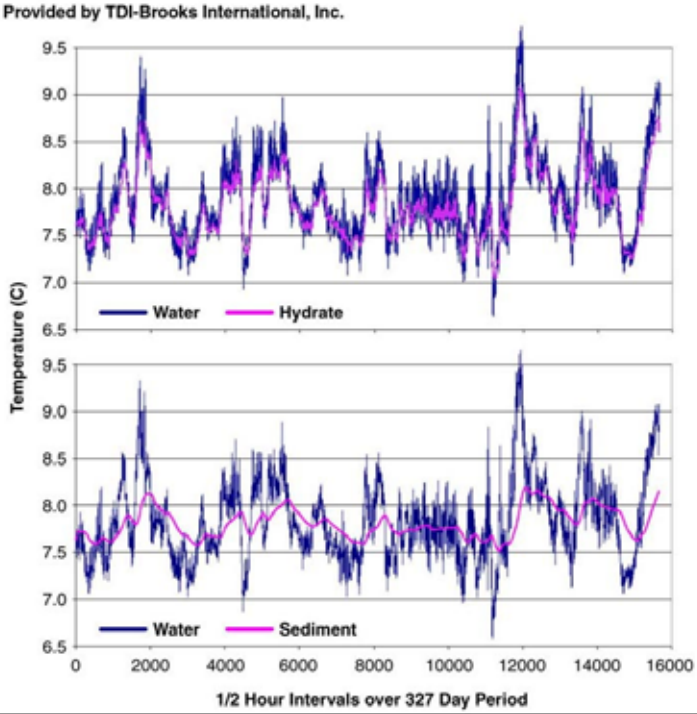
Exposed Hydrate Mound with Johnson Sea Link Submersible in Background

CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

There were two recording thermistors in each probe, one at the top to measure temperature in the water and one at the bottom to measure temperature in the sea-floor hydrate and mud.

Measurements at 30-minute intervals over about 11 months are presented graphically on the next slide.

The University of Mississippi



CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

Preliminary results of the temperature measurements are:

1) **No dramatic changes in size, shape or amount of gas being venting.**

2) **Mean temperatures** **7.87 °C in water**
7.81 °C in both hydrate and sediment.

3) **subbottom temperatures lag behind water temperatures.**

Further analysis is expected to advance efforts to model and understand thermal response (i.e. thermal conductivity) of exposed hydrate deposits.

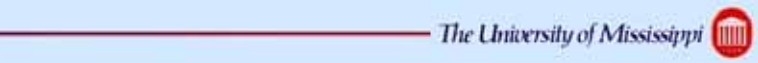
Re: I. MacDonald, M. Vardaro, B. Bernard, J. Brooks

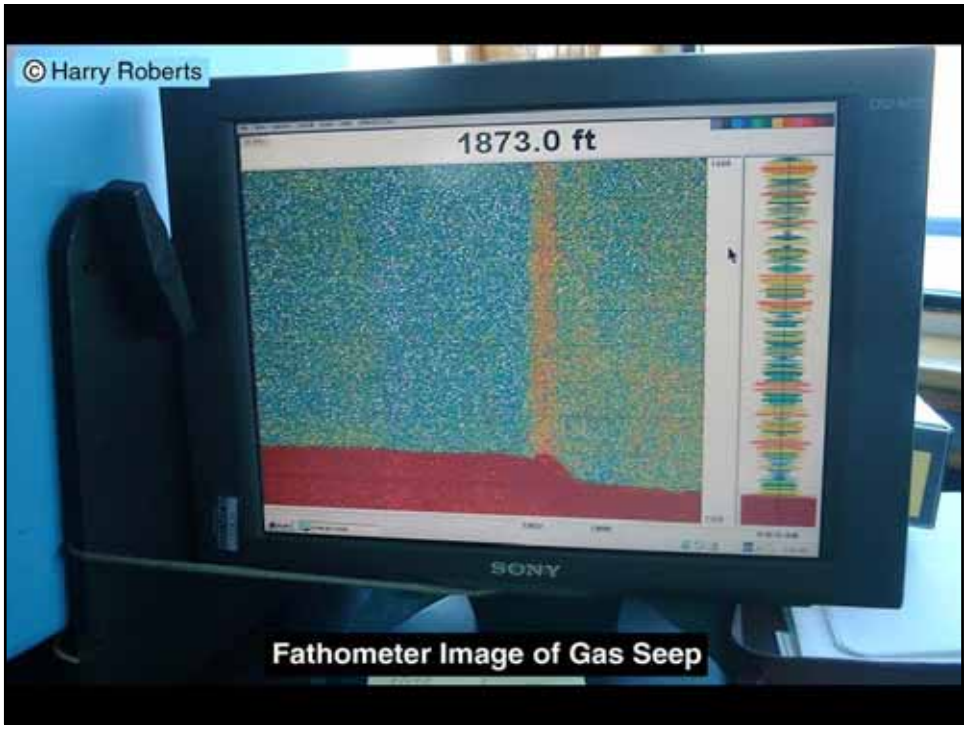
The University of Mississippi

CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

Gas activity has been observed
by depth sounders mounted on surface vessels
and
by current meters located on the sea floor.

The University of Mississippi



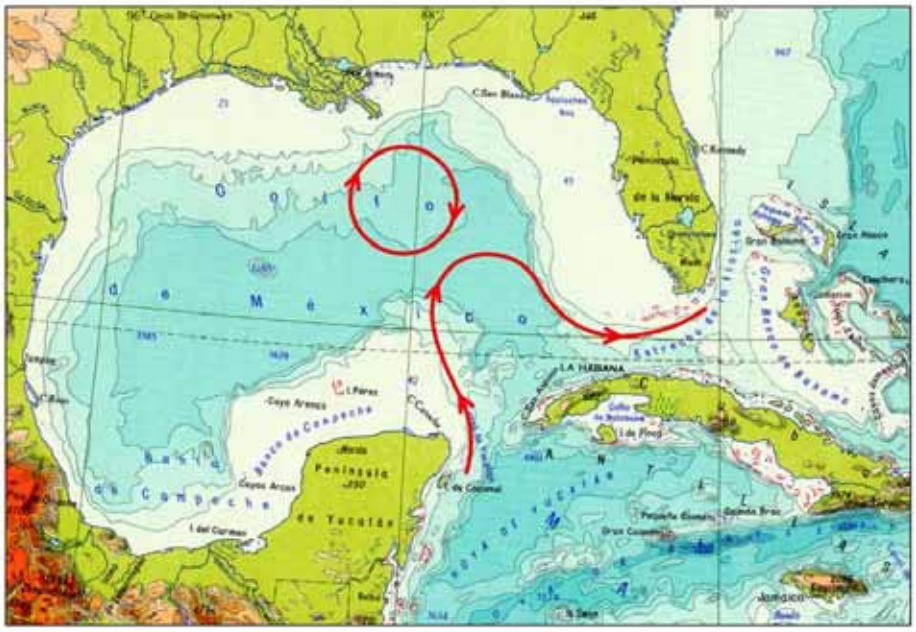

© Harry Roberts
1873.0 ft
SONY
Fathometer Image of Gas Seep


© Harry Roberts
Device for Measuring Gas from Seeps

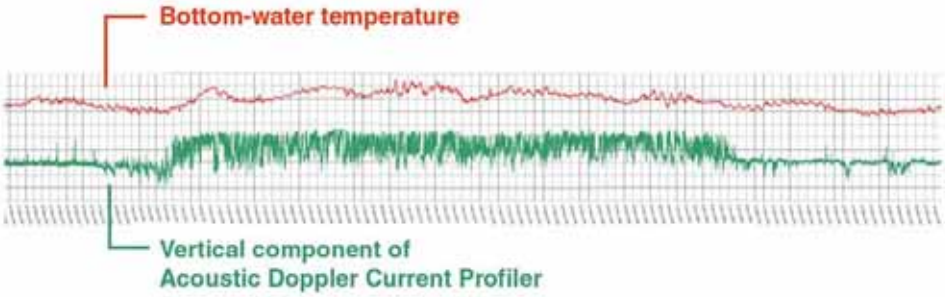
CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

Gas activity has been observed to be correlated with increases in bottom-water temperature caused by warm-water eddies that detach from the principal current in the Gulf of Mexico, the Loop Current, and drift westward along the Louisiana-Texas continental slope.

The University of Mississippi



Loop Current and Detached Eddy



Temperature and Gas Activity
During Passage of Loop Eddy (Re: Harry Roberts)

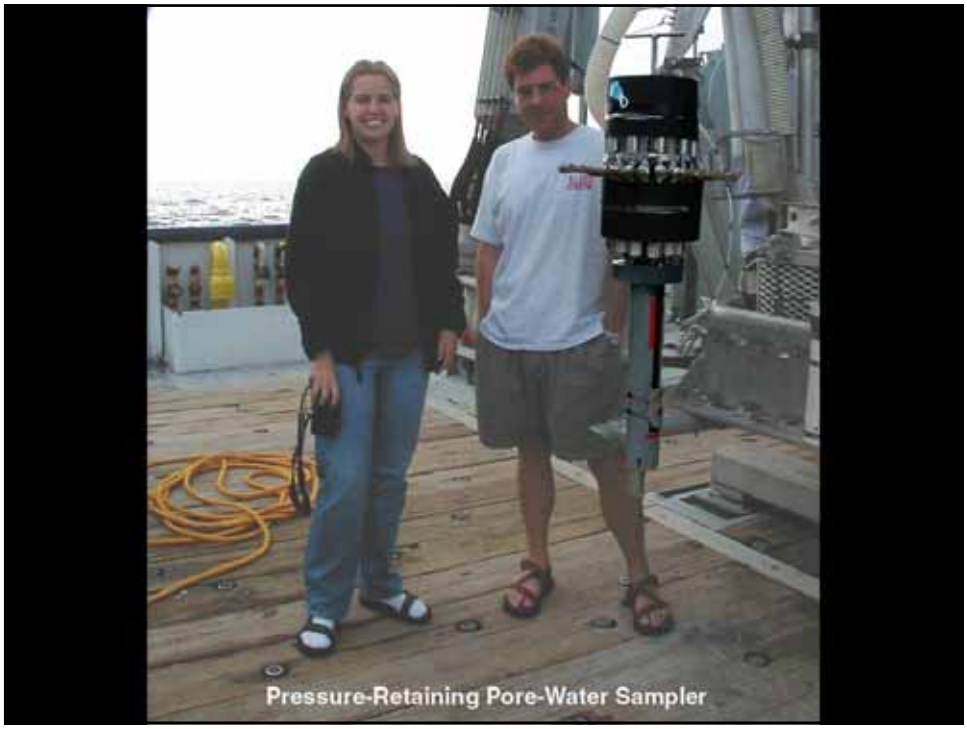
CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

A device to sample pore water at ten locations in the upper meter of sea-floor sediment and return the samples to the surface under pressure was designed and built by researchers from Florida State University and the University of North Carolina.

It was successfully deployed by the Johnson SeaLink.

Initial results reveal the highest concentrations of dissolved hydrocarbons yet reported.

The University of Mississippi



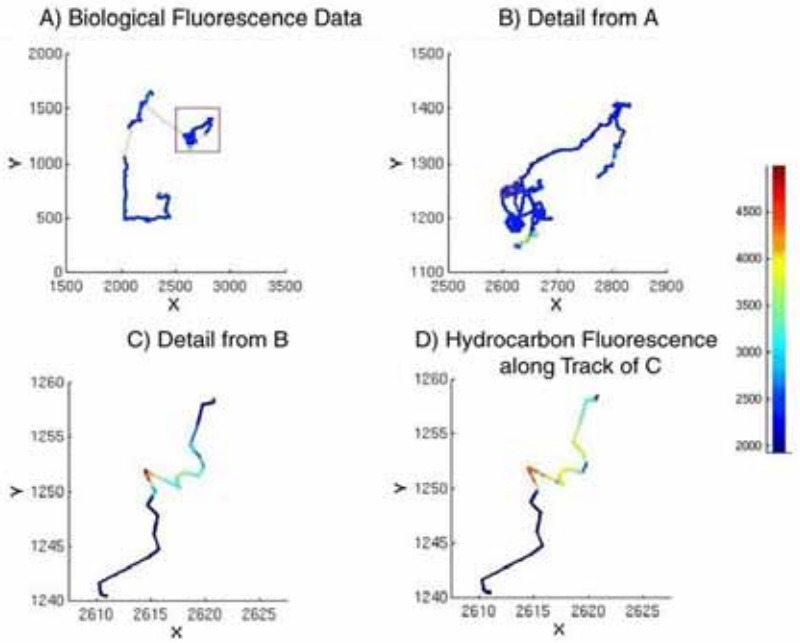
CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

The Woods Hole Oceanographic Institution and The University of Victoria, British Columbia, helped WellDog, Inc. to design modifications to improve the resolution of the Raman spectrometer built by WellDog.

The device is intended to be mounted on a submersible to analyze hydrocarbons near sea-floor seeps.

The need to detect variations over small distances is illustrated by the flourometer measurements presented in the next slide.

The University of Mississippi



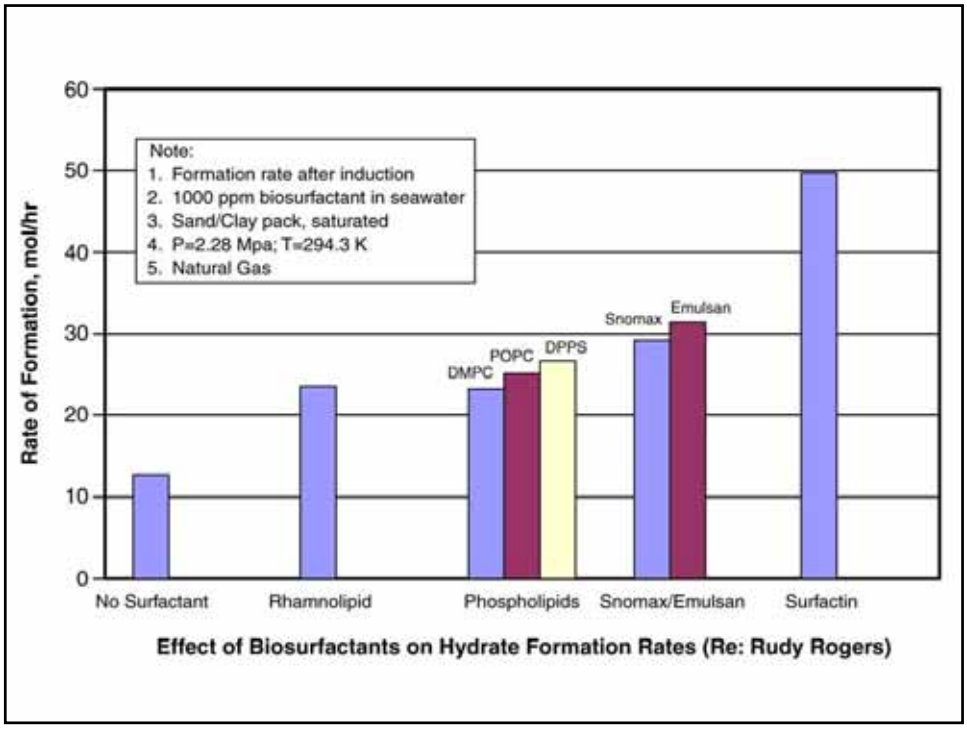
Scale Comparison of Fluorometer Measurements (Re: Jean Whelan)

CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

Laboratory studies of hydrate formation continued at Mississippi State University.

This work has already demonstrated the significant impact of bacterially produced surfactants on the rate of hydrate formation.

The University of Mississippi



CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

The University of Mississippi and the University of Wales (Bangor) carried out shear-wave studies using a hydrophone and a 3-component accelerometer mounted in a probe that was pushed into sediments of the shallow water in Mississippi Sound.

The sensors and the probing mechanism are shown in the following two slides.

The University of Mississippi


© Jeff Chanton
Probe Sensor (Hydrophone and 3-Component Accelerometer)


© Jeff Chanton
Mechanism for Pushing Probe into Sea Floor

CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

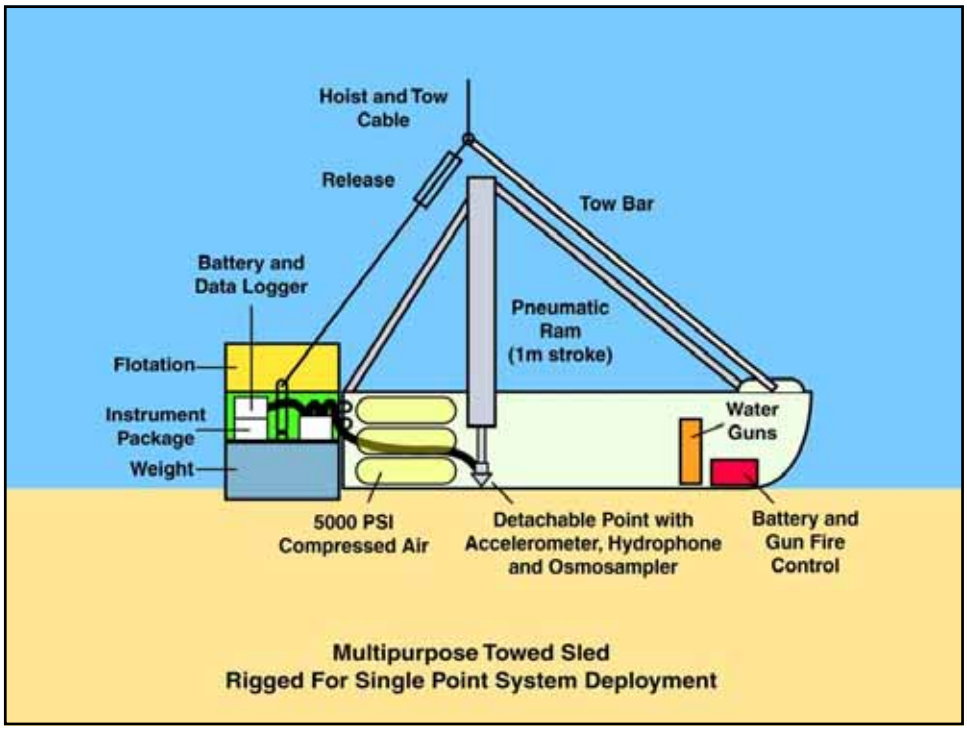
A sled to carry out shear-wave studies in the deep water of the Gulf of Mexico is being designed and constructed.

The sled will be capable of two modes of sensor deployment for enhanced shear-wave coupling in soft sediment:

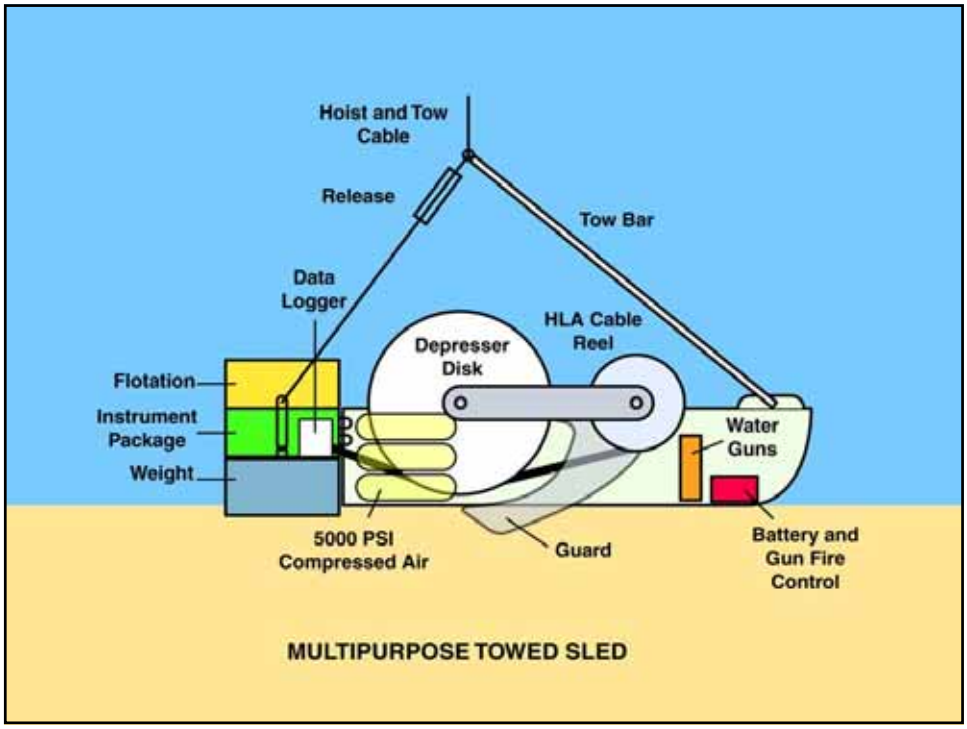
1) **point-by-point vertical insertion of 4-component sensor into the sea floor using a pneumatic piston;**

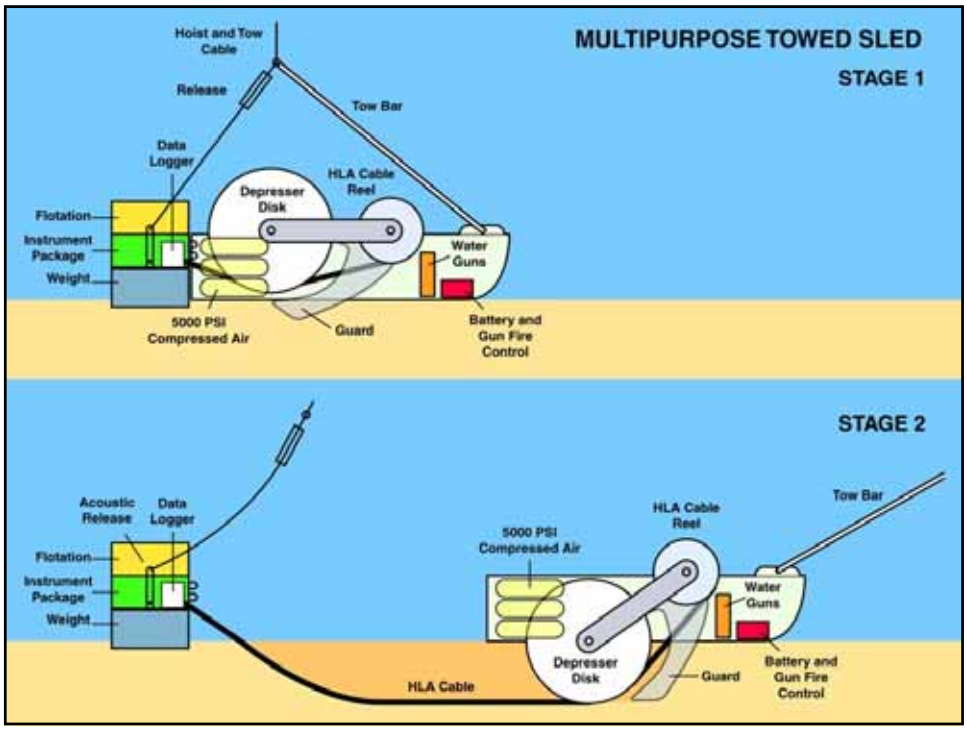
2) **burying a horizontal, 4-component array in the sea floor, using a gravity depressor disk, as pictured in following slides.**

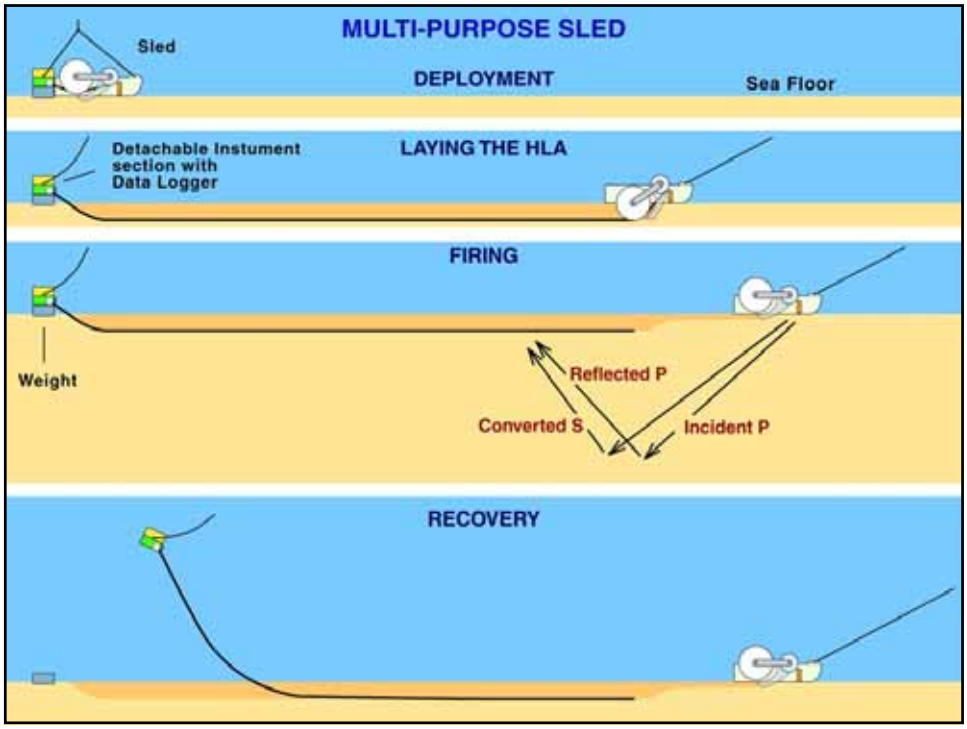
The University of Mississippi



Multipurpose Towed Sled
Rigged For Single Point System Deployment


Hoist and Tow Cable
Release
Tow Bar
Data Logger
HLA Cable Reel
Depresser Disk
Flotation
Instrument Package
Weight
Water Guns
5000 PSI Compressed Air
Guard
Battery and Gun Fire Control
MULTIPURPOSE TOWED SLED


MULTIPURPOSE TOWED SLED
STAGE 1
Hoist and Tow Cable
Release
Tow Bar
Data Logger
HLA Cable Reel
Depresser Disk
Flotation
Instrument Package
Weight
Water Guns
5000 PSI Compressed Air
Guard
Battery and Gun Fire Control
STAGE 2
Acoustic Release
Data Logger
Flotation
Instrument Package
Weight
HLA Cable Reel
Tow Bar
5000 PSI Compressed Air
Water Guns
Depresser Disk
Guard
Battery and Gun Fire Control
HLA Cable



CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

In both modes, the sled will carry

two 15 in^3 water gun seismic sources

to excite shear waves.

The University of Mississippi

CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

The objective of the monitoring station consortium

was expanded substantially during 2003

by DOE's request that the consortium

more actively support the JIP.

The University of Mississippi

CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

The consortium's task in support of the JIP

is to construct a relatively low-cost linear array of

pressure, temperature and ground-motion sensors.

The University of Mississippi

CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

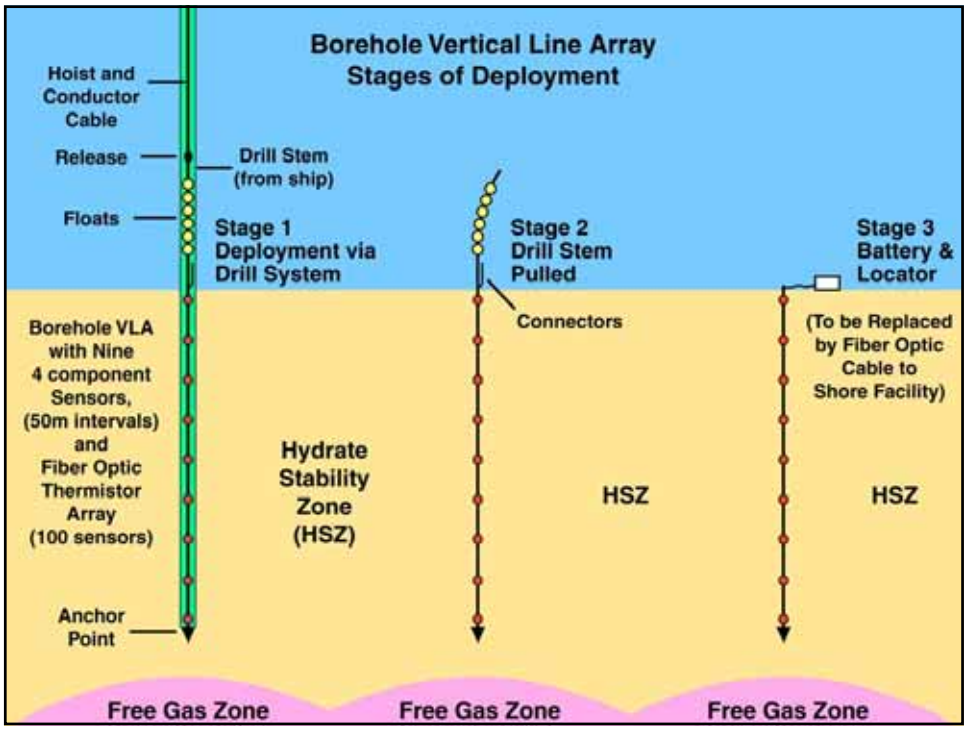
The array will be placed in a borehole

in order to monitor

the interior of the hydrate stability zone

over an extended period of time.

The University of Mississippi



CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

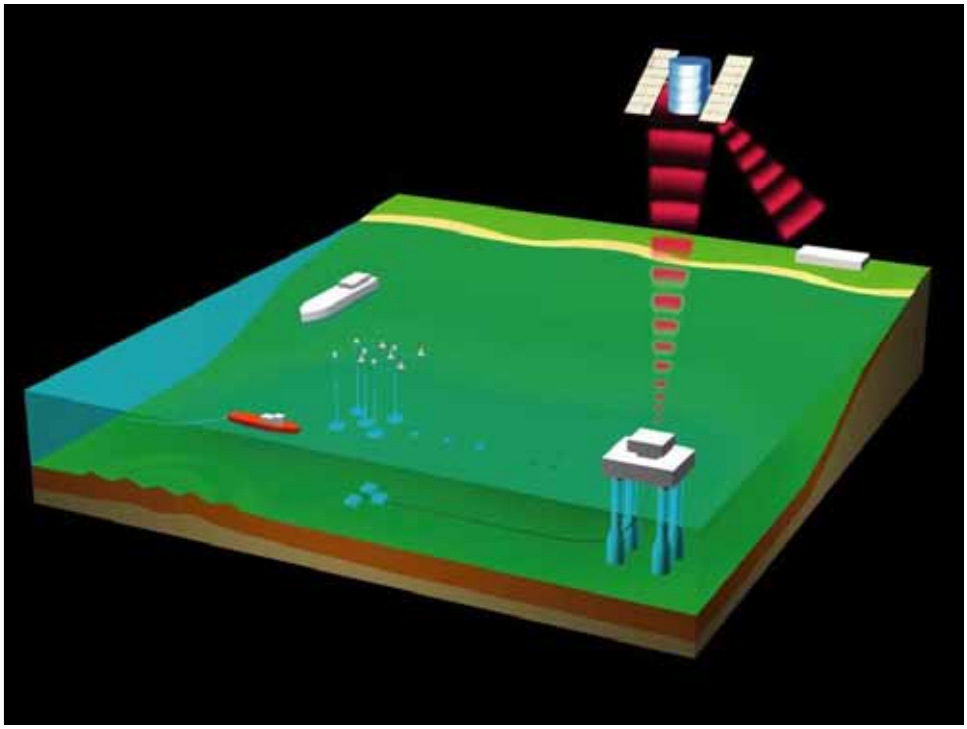
A problem that is now being addressed by the consortium is that of how to transmit the monitoring data to shore.

The University of Mississippi

CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

The possibility of using an existing oil production platform to solve both has been discussed but has not seemed very appealing because it would seriously limit the choice of monitoring station sites.

The University of Mississippi

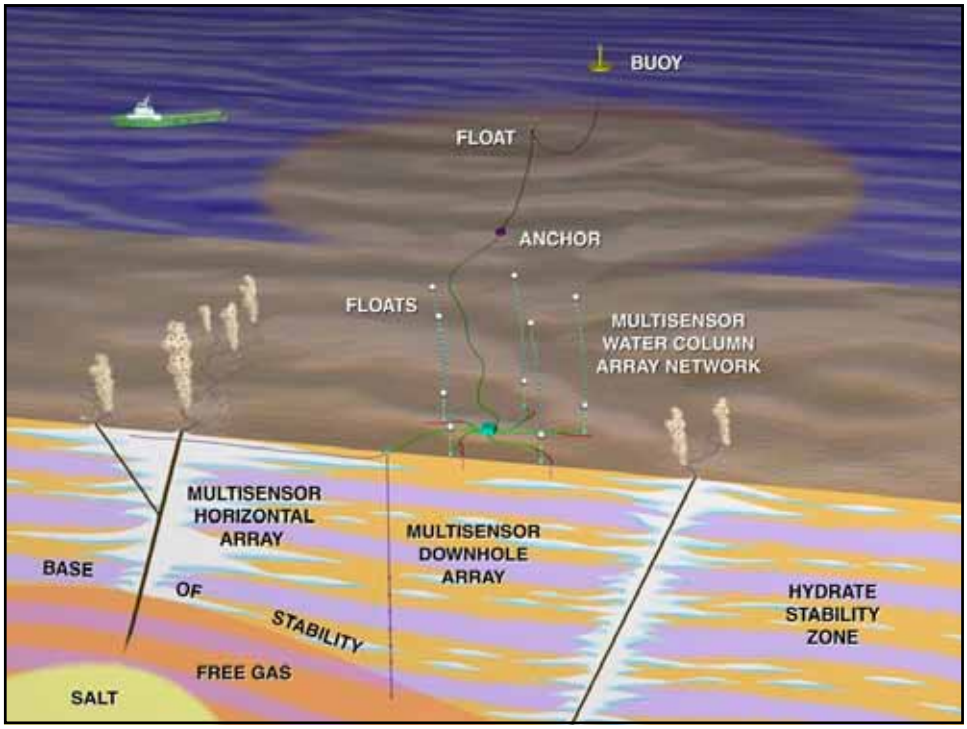


CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

The NOAA National Data Buoy Center at Stennis Space Center has expressed an interest in providing a buoy to bring the data to the surface.

It has also expressed interest in engineering the transmission of limited data over the NOAA satellite system to the Stennis facility.

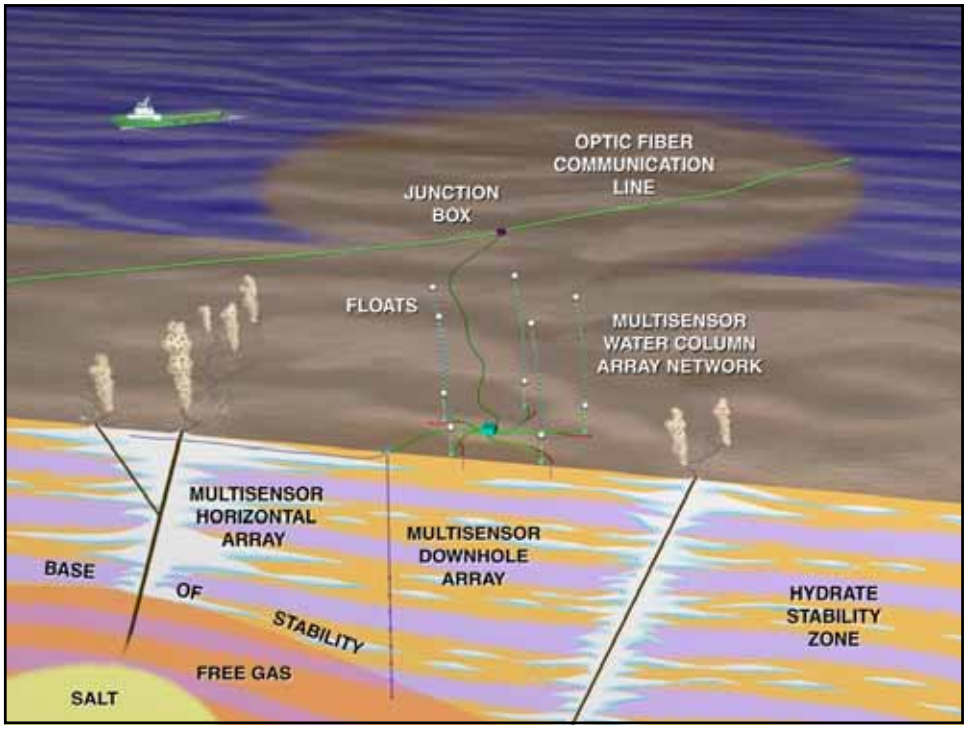
The University of Mississippi



CMRET CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY

A third possibility is that the monitoring data can be transmitted to shore by an optic fiber network that is planned for installation in the Gulf of Mexico by private industry.

The University of Mississippi


OPTIC FIBER
COMMUNICATION
LINE
JUNCTION
BOX
FLOATS
MULTISENSOR
WATER COLUMN
ARRAY NETWORK
MULTISENSOR
HORIZONTAL
ARRAY
MULTISENSOR
DOWNHOLE
ARRAY
BASE
OF
STABILITY
FREE GAS
SALT
HYDRATE
STABILITY
ZONE