“Characterizing Natural Gas Hydrates in the Deep Water Gulf of Mexico: Applications for Safe Exploration and Production Activities Semi-Annual Report”

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Submitting Organization:
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ABSTRACT

In 2000, Chevron began a project to learn how to characterize the natural gas hydrate deposits in the deepwater portions of the Gulf of Mexico. A Joint Industry Participation (JIP) group was formed in 2001, and a project partially funded by the U.S. Department of Energy (DOE) began in October 2001. The **primary objective** of this project is to develop technology and data to assist in the characterization of naturally occurring gas hydrates in the deep water Gulf of Mexico (GOM). These naturally occurring gas hydrates can cause problems relating to drilling and production of oil and gas, as well as building and operating pipelines. Other objectives of this project are to better understand how natural gas hydrates can affect seafloor stability, to gather data that can be used to study climate change, and to determine how the results of this project can be used to assess if and how gas hydrates act as a trapping mechanism for shallow oil or gas reservoirs.

During April 2005 – September 2005, the JIP concentrated on:

- Executing the drilling leg in April and May of 2005;
- Conducting experiments on the cores collected;
- Analyzing the log data collected;
- Developing the lessons learned from the cruise.

More information can be found on the JIP website.

https://cpln-www1.chevrontexaco.com/cvx/gasjip.nsf

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1.0 Introduction

In 2000, Chevron Petroleum Technology Company began a project to learn how to characterize the natural gas hydrate deposits in the deepwater portion of the Gulf of Mexico. Chevron is an active explorer and operator in the Gulf of Mexico, and is aware that natural gas hydrates need to be understood to operate safely in deep water. In August 2000, Chevron working closely with the National Energy Technology Laboratory (NETL) of the United States Department of Energy (DOE) held a workshop in Houston, Texas, to define issues concerning the characterization of natural gas hydrate deposits. Specifically, the workshop was meant to clearly show where research, the development of new technologies, and new information sources would be of benefit to the DOE and to the oil and gas industry in defining issues and solving gas hydrate problems in deep water.

On the basis of the workshop held in August 2000, Chevron formed a Joint Industry Project (JIP) to write a proposal and conduct research concerning natural gas hydrate deposits in the deepwater portion of the Gulf of Mexico. The proposal was submitted to NETL on April 24, 2001, and Chevron was awarded a contract on the basis of the proposal.

The title of the project is

"Characterizing Natural Gas Hydrates in the Deep Water Gulf of Mexico: Applications for Safe Exploration and Production Activities".

1.2 Objectives

The **primary objective** of this project is to develop technology and data to assist in the characterization of naturally occurring gas hydrates in the deep water Gulf of Mexico (GOM). These naturally occurring gas hydrates can cause problems relating to drilling and production of oil and gas, as well as building and operating pipelines. Other objectives of this project are to better understand how natural gas hydrates can affect seafloor stability, to gather data that can be used to study climate change, and to determine how the results of this project can be used to assess if and how gas hydrates act as a trapping mechanism for shallow oil or gas reservoirs.

1.3 Project Phases

The project is divided into phases. **Phase I** of the project is devoted to gathering existing data, generating new data, and writing protocols that will help the research team determine the location of existing gas hydrate deposits. During **Phase II** of the project, Chevron will drill at least three data collection wells to improve the technologies required to characterize gas hydrate deposits in the deep water GOM using seismic, core and logging data.

1.4 Research Participants

In 2001, Chevron organized a Joint Industry Participation (JIP) group to plan and conduct the tasks necessary for accomplishing the objectives of this research project. As of September 2005 the members of the JIP were Chevron, Schlumberger, ConocoPhillips, and Halliburton, the Minerals Management Service (MMS), Total, JOGMEC, and Reliance Industries Limited.

1.5 Research Activities

The research activities began officially on October 1, 2001. However, very little activity occurred during 2001 because of the paperwork involved in getting the JIP formed and the contract between DOE and Chevron in place. Several Semi-Annual and Topical Reports have been written that cover the activity of the JIP through March 2005.

1.6 Purpose of This Report

The purpose of this report is to document the activities of the JIP during April 2005 – September 2005. It is not possible to put everything into this Semi-Annual report. However, many of the important results are included and references to the JIP website are used to point the reader to more detailed information concerning various aspects of the project. The discussion of the work performed during April 2005 – September 2005 is organized by task and subtask for easy reference to the technical proposal and the DOE contract documents.

More detailed information generated by the JIP during April 2005 – September 2005 can be found on the JIP website. The link to the JIP website is as follows:

https://cpln-www1.chevrontexaco.com/cvx/gasjip.nsf

2.0 Executive Summary

Chevron formed a Joint Industry Participation (JIP) group to write a proposal and conduct research concerning natural gas hydrate deposits in the deepwater portion of the Gulf of Mexico. The proposal was submitted to NETL on April 24, 2001, and Chevron was awarded a contract on the basis of the proposal.

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The **primary objective** of this project is to develop technology and data to assist in the characterization of naturally occurring gas hydrates in the deep water Gulf of Mexico (GOM). **Other objectives** of this project are to better understand how natural gas hydrates can affect seafloor stability, to gather data that can be used to study climate change, and to determine how the results of this project can be used to assess if and how gas hydrates act as a trapping mechanism for shallow oil or gas reservoirs.

The project is divided into phases. **Phase I** of the project is devoted to gathering existing data, generating new data, and writing protocols that will help the research team determine the location of existing gas hydrate deposits. During **Phase II** of the project, Chevron will drill at least three data collection wells to improve the technologies required to characterize gas hydrate deposits in the deep water GOM using seismic, core and logging data.

A website has been developed to house the data and information that were collected in the Workshop, as well as other items submitted during the course of this research endeavor. The link to the JIP website is as follows:

https://cpln-www1.chevrontexaco.com/cvx/gasjip.nsf.

2.1 Research Plan and Management

A Continuation Application for Phase II was submitted to the DOE on 15 May 2003. Several changes were required to the original plan because of delays due to EPA permitting, and drill ship changes.

2.2 Sensors

A pressurized measurement vessel and the equipment required to move a core from a pressure coring device into the measurement vessel was constructed and tested during the Leg 1 Cruise. The equipment performed well and properties on one core were measured.

2.3 Drilling and Science Planning

Detailed science and drilling plans were executed. However, a number of adjustments to both the drilling schedule and science plan were required because of operational problems and extra time required to complete tasks.

2.4 Logging Operations

Logging while drilling (LWD), wire line logging, and vertical seismic profile (VDP) data were collected. In general the log data were of good to high quality.

3.0 Results and Discussion Phase II

3.1 Task 1.0 – Research Management Plan

The goals of this task are to develop a work breakdown structure and supporting narrative that concisely addresses the overall project as set forth in the agreement. Provide a concise summary of the technical objectives and technical approach for each Task and, where appropriate, for each subtask. Provide detailed schedules and planned expenditures for each task including any necessary charts or tables, and all major milestones and decision points.

A Continuation Application for Phase II was submitted to the DOE on 15 May 2003. Additional documentation was supplied to the DOE in November and December of 2003, March, July, and December of 2004, and the research plan was revised again in

January 2005 to allow for the additional cost of the drilling vessel. Several changes were required to the original plan because of delays due to EPA permitting, and drill ship changes.

3.2 Task 2.0 – Project Management and Oversight

A project manager appointed by the Joint Industry Project (JIP) Recipients will manage the technical teams, contractors, and the day to day operation of the project. Project manager will report, verbally and through required reporting, on the progress of the program to the DOE and the JIP as required.

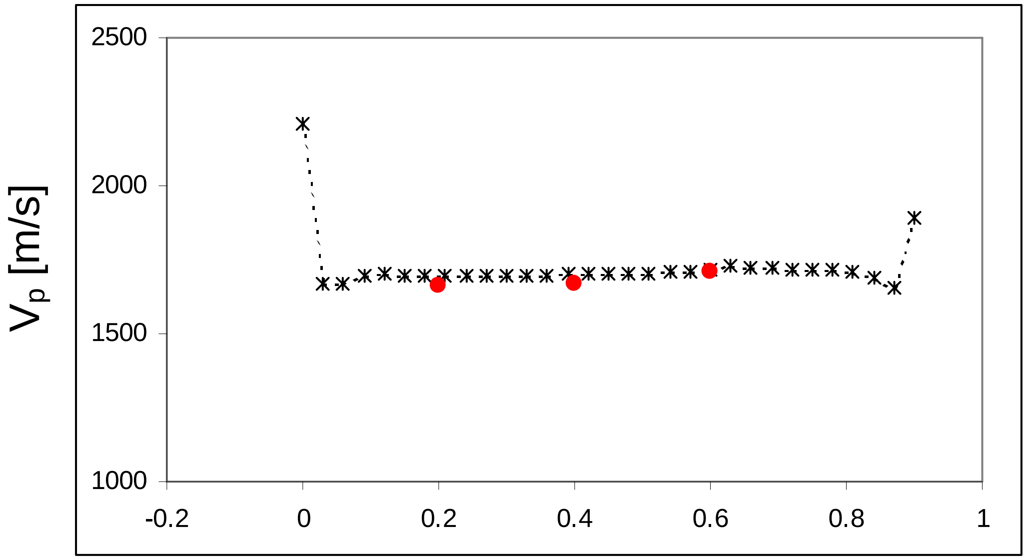
During the period of the progress report the JIP and DOE project managers were in regular contact discussing changes to the research plan. The DOE project manager also spent a few days on the drill ship during the Atwater Valley drilling operation.

3.3 Task 3.0 – Validation of New Gas Hydrate Sensors

Review and evaluate new hydrate sensor development (Phase I – Task 4, Subtasks 4.1 – 4.4). Prototype sensors, if available, will be field tested in well bores and protocols for use will be developed and distributed to all entities involved in drilling wells in the Gulf of Mexico.

The pressurized core measurement vessel, developed by Georgia Tech, and transfer vessels were tested during the Leg 1 cruise. After some initial adjustment, the equipment worked and one pressure core was transferred into the measurement vessel for testing.

Figure 3.1. Data from the Pressure Core Measurement Vessel



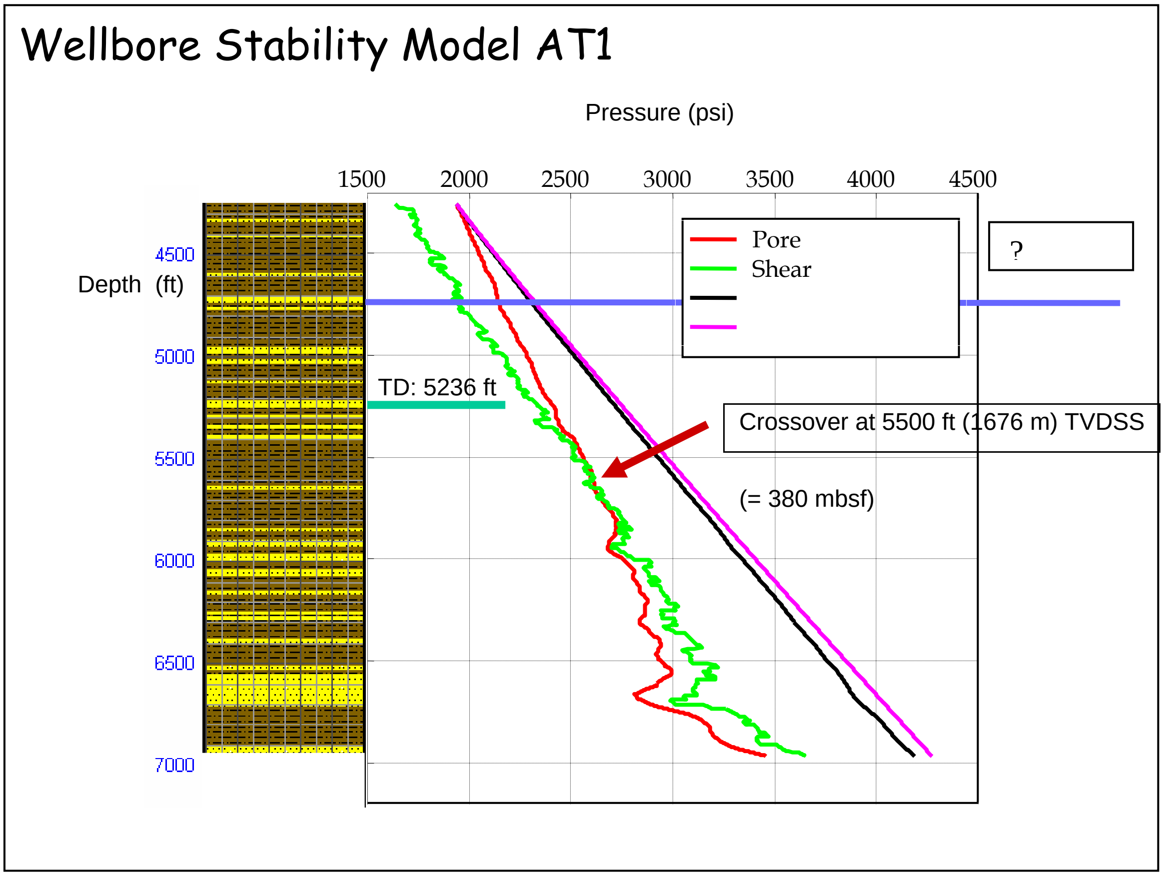
The data presented in Figure 3.1 are from Keathley Canyon at 227 mbsf.

3.4 Task 4.0 – Validation of the Well Bore Stability Model

The goal of this task is to revise the well bore stability model, developed in Phase I – Task 5.0 – Subtasks 5.1 – 5.4, using laboratory data and to validate the model using all available information. Changes or improvements will be made and the model will be distributed for use by organizations drilling wells in the Deep Water Gulf of Mexico.

The well bore model developed in Phase I was used to predict pore pressure and well bore stability before the Leg 1 Cruise. During the cruise one the staff responsible for the well bore model collected data necessary to determine the performance of the model.

Figure 3.2. Well Bore Stability Model Prediction for Atwater Valley 1 Hole



3.5 Task 5.0 – Core and Well Log Data Collection – Area A

In order to develop the necessary ground truth data twin wells in the most favorable location for gas hydrates identified in Phase I – Tasks 11/12 – Subtasks 11.1 – 11.5 (this will be designated Area A) will be drilled. Well A-1 will be drilled without well control and will gather drilling, MWD and openhole logging information. Well A-2 will be drilled with well control and will gather drilling, MWD, core and openhole logging information. The wells will be surveyed and the core will be sent to laboratories for analyses. An additional well, A-3, will be drilled in the least favorable location for gas hydrates in Area A and appropriate core, logging and drilling data will be obtained.

Leg 1 drilling was conducted at two locations, Atwater Valley and Keathley Canyon, in the GOM. In both locations holes were drilled to collect log and core data. In addition to the two primary wells drilled in Atwater Valley two short wells were drilled near the center of mound. The location of the holes is presented in Appendix A, Figures A2 and A3.

Summary of Leg 1 Drilling

<u>Holes Drilled / Footage:</u>

Seven (7) wells, total of 5,540 ft drilled.

AT13 #1 – 809' BML
AT14 #1 – 941' BML
AT13 #2 – 656' BML
ATM1 – 80' BML
ATM2 – 103' BML
KC151 #2 – 1506' BML
KC151 #3 – 1445' BML

<u>Cores Types Used & Recovery:</u>

Fugro Hydraulic Piston Corer (FHPC) – 23 deployments, 570' recovered (95%)
Fugro Corer (FC) – 13 deployments, 90' recovered (59%)

> The % recovery for FC and FHPC can be misleading. The % recovered is based on total barrel length. Sometimes due to stiffness of formation, the total penetration was not achieved. Conversely, sometimes more than the penetration can be recovered due to expansion in the formations in the barrel.

Hyace Rotary Corer (HRC) – 9 deployments, 6' recovered (2 cores successfully recovered under pressure) – 20% footage recovery
Fugro Pressure Corer (FPC) – 9 deployments, 10' recovered (3 cores successfully recovered under pressure) – 38% footage recovery
Total – 53 cores taken, 302' recovered (76% of total maximum possible).

<u>Hydrate Recovery (to date):</u>

Two (2) HRC cores were recovered and recovered hydrate
One (1) FC was recovered with a piece of hydrate still evident in the core
One (1) FPC was recovered with evidence of hydrate and is still under pressure.
Other cores had evidence of hydrate but no physical recovery was able to be made due to dissociation.

<u>Log Data:</u>

AT13#1, AT14#1 and KC151 #2

Resistivity, borehole imaging, gamma ray, density, neutron porosity, and magnetic resonance

KC151 #3

Dipole sonic, general inclination & orienting tool, VSP

The quality of the log data was very good for all the wells where log data was obtained especially given the potential conditions for poor logs in the shallow sediments.

Basic Summary of Core Analyses Done:

Infrared scan of all cores
Pore water chemistry
X-ray of cores
CT scans
Controlled degassing of pressurized hydrate cores
Simple strength tests
Gas analysis
P-wave and gamma ray imaging of cores
Density of cores
Re-pressurizing of degassed cores and re-evaluation of characteristics

Test to be Done:

Sediment analysis and description
Extended water analysis
Extended gas analysis
Mechanical and acoustic analysis of cores reconstituted in lab
Analysis of hydrate structure (if enough was preserved)
Background gamma ray on cores
Split cores, image and describe

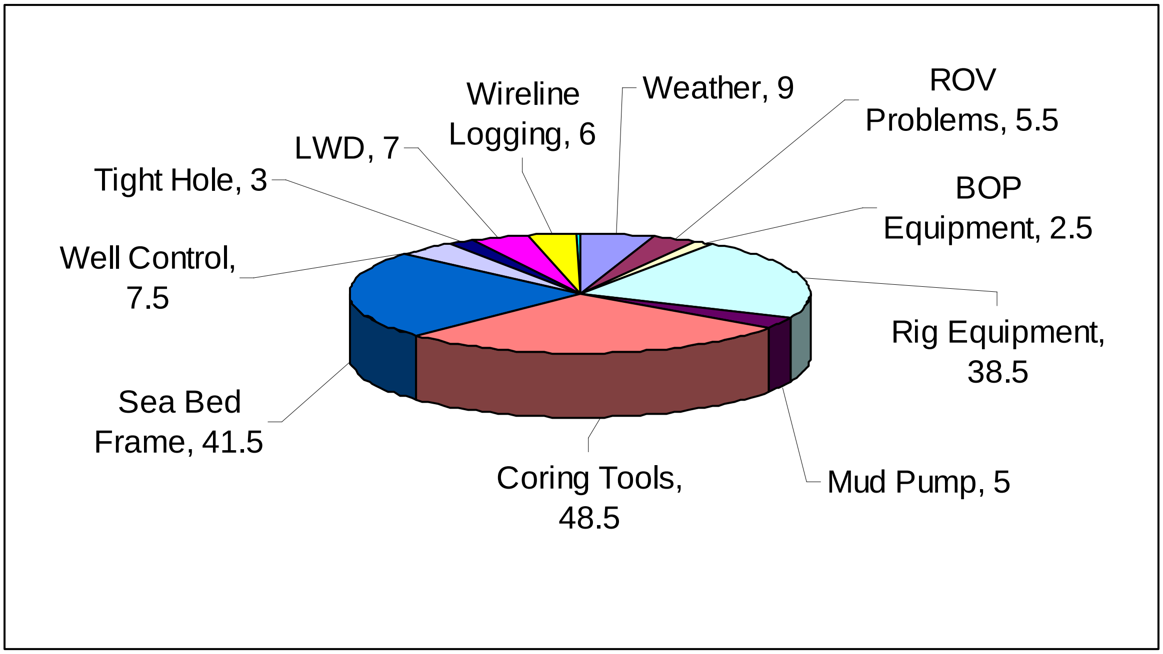
Other Highlights

Project completed with Zero Health, Environmental or Safety incidents (>48,300 man hours)
First ever attempt at subsurface hydrate recovery in Gulf of Mexico
Tested / utilized emerging technologies with pressurized coring devices
Fugro pushed the FHPC to deeper depths then it previously had.

Plan Forward:

Complete post cruise analysis of cores and logs
Compare results to precruise analysis.
Determine the necessary additional research required.
Conduct a public workshop to report results.

Figure 3.5.1. Down Time in Hours for Leg 1 Drilling



Overall there were 174.5 of downtime hours and 918 operating hours which yields a down time of 19%.

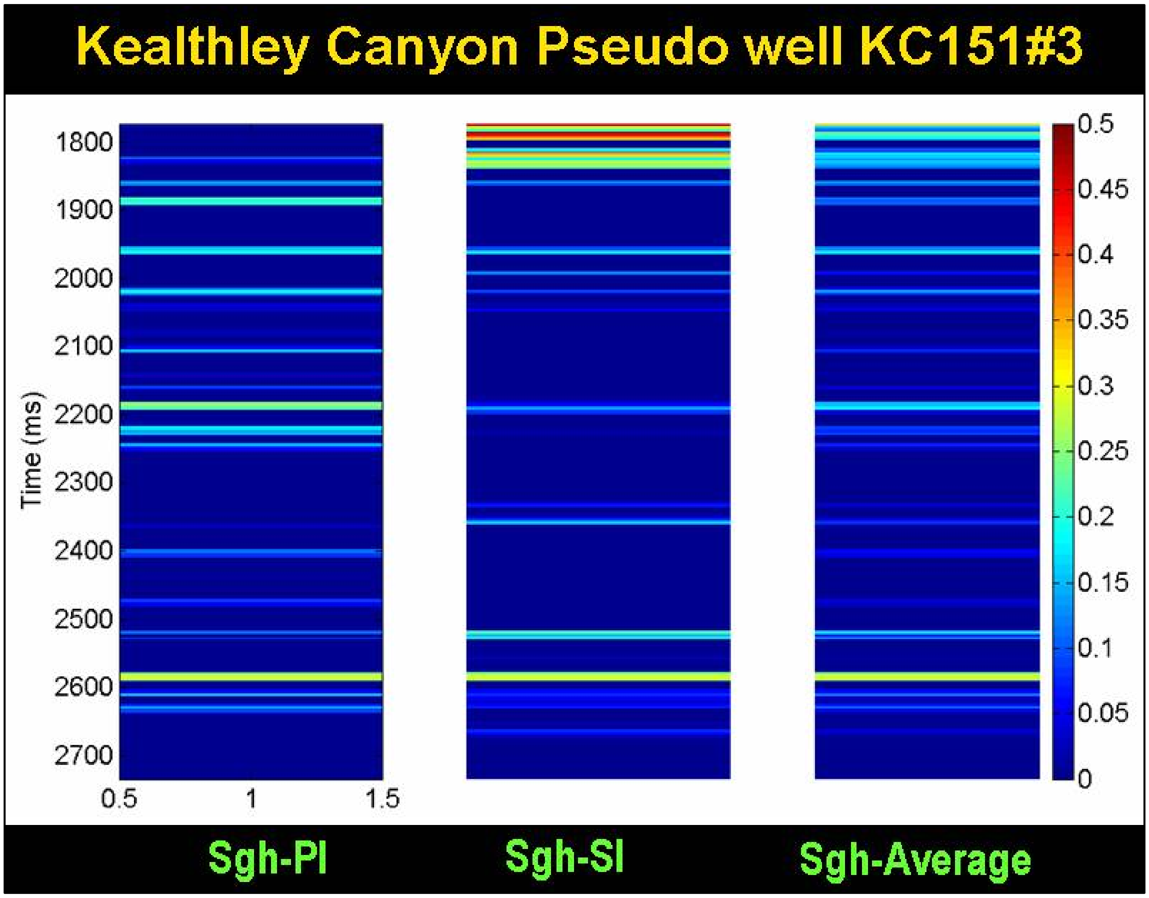
Additional details of the drilling operation may be found in Appendix B.

3.6 Task 6.0 – Data Analysis – Initial Cruise

Work under this task will consist of conducting the appropriate analysis of all data obtained during initial field activities (the April—May 2005 activities at the Atwater Valley and Keathley Canyon sites) and provide an initial Scientific Results report that details the following: a) the pre-cruise seismic interpretations and an analysis comparing those interpretations with actual findings; b) the findings of the geochemical surveys; c) the findings of the well logging efforts and analysis; d) the findings of the borehole geophysical surveys; e) the performance of various sampling devices employed; f) as well as any other appropriate results emanating from shipboard or subsequent analysis of data or samples obtained during the cruise.

Data from Drilling Leg 1 was collected both during the cruise and after the cruise at various labs. Appendix A, Table A2, contains a list of the properties that were targeted for measurement on the ship and at shore-based facilities. Appendix A also contains a copy of the daily science reports filed during the cruise. Appendix E contains a copy of the logging report filed during the cruise. The logging report is the initial analysis of the log data and is subject to change after the complete log data is processed and analyzed.

Figure 3.3. Precruise Hydrate Concentrations for KC 151



3.7 Task 7.0 – Technical Conference

In order to provide the scientific community with current data from the project a workshop will be conducted to present all information obtained during the course of the project to industry, academic, government and other interested professionals. This workshop will focus on the opportunities for improving the tools and protocols for effective field investigation of hydrates in the Gulf of Mexico. The output of the workshop will be plans for DOE consideration for acting on specific recommendations arising from this workshop.

A workshop to present the findings to date is being planned for April of 2006.

3.8 Task 8.0 – Field Sampling Device Development

In addition to any specific data/tool needs identified in the Task 7 workshop, the acquisition of improved technologies for the acquisition, retrieval and subsequent analysis of samples under in-situ pressure (and possibly temperature) conditions will be pursued. Pressure coring equipment will be evaluated both from the JIP membership and the development of new devices to accomplish these goals (both sample retrieval and extensive analysis of samples in systems capable of minimizing hydrate dissociation and sample alteration from its natural state).

3.9 Task 9.0 – Recommendation for Further Activities

Analysis of initial cruise findings will be used to determine the need for additional field activities to properly characterize the full range of hydrate occurrences in the Gulf. New locations will be selected and evaluation of existing geophysical and well log data will be conducted to evaluate the existence of sites or the location of favorable transects in the Gulf of Mexico that have the best potential to provide the missing data. Recommendations will be prepared for a second phase of field activities, including a description of the sites and a plan for conducting field operations.

4.0 Discussion and Results PHASE III – Follow on Field Activities and Final Reporting

Tentative tasks are provided for Task III activities, which will include the execution of a second field program as identified in Phase II/Task 9.0, and full reporting to both DOE and the broader scientific community.

4.1 Task 1.0 – Research Management Plan

Develop a work breakdown structure and supporting narrative that concisely addresses Phase III activities and includes a concise summary of activities, schedules and costs for each Phase III Task.

4.2 Task 2.0 – Project Management and Oversight

A project manager appointed by the Joint Industry Project (JIP) Recipients will manage the technical teams, contractors, and the day to day operation of the project. Project manager will report, verbally and through required reporting, on the progress of the program to the DOE and the JIP as required.

4.3 Task 3.0 – Field Activities

Conduct field operations as developed in Phase II Task 9.0 and outlined in Phase III Task 1.0.

4.4 Task 4.0 – Data Analysis

Conduct appropriate analysis of all data obtained during the Phase III cruise, integrate these data with those from the Phase II cruise, and provide a detailed Final Report on the findings and their implications. Recommend and pursue options for providing this report as a Special Volume in a manner similar to that provided from other large-scale hydrate research efforts (for example, the special volumes emanating from the Mallik programs).

4.5 Task 5.0 – Technical Conference

Conduct a technical conference to present all information obtained during the course of the project to industry, academic, government and other interested professionals.

5.0 Experimental

Experimental work was conducted during the period of this report. Photos and drawings of some of the experimental equipment that was used on the cruise are presented in Appendices. Other drawings and photos of the experimental equipment were presented in previous semiannual reports.

6.0 Conclusions

Precruise estimates of hydrate concentrations ranged up to 20% of pore space. The sediments should be mostly silts and clays with only a few possible thin sands. Analysis of the cores and logs collected during the cruise indicated approximately the same concentrations and locations for hydrates.

The aggressive science plan had to be reduced because of drilling, weather, and other delays.

Drilling plan time estimates allow for only the bare minimum of down time and drilling delays. Additional problems were encountered and the staff on the ship adjusted the science plan to remain within the budget.

Testing and first use of the pressurized measurement vessel developed by Georgia Tech was completed. The vessel requires the use of transfer vessels and core manipulators that were developed and tested in the lab but this was the first use of the equipment in an actual cruise. The equipment worked well but additional testing will be required because of the low number of pressure cores recovered.

7.0 References

No external references were used for this report.

8.0 Appendix

Appendix A. Science Plan

Table A1. Hole Locations and Target Depths

Name	PROPOSED HOLE LOCATION	INLINE	TRACE	X	Y	LAT	LONG	2WT WB	DEPTH WB	2WT TD	DEPTH TD	DEPTH BML TD
KC3L	KC151 #3 Open	5700	20248	1643513.88000	9733112.29000	26° 49' 22.6" N	92° 59' 25.8" W	1.782	4375	2.407	6190	1815
KC1L	KC151 #1 Open	5700	20280	1644827.03010	9733112.40830	26° 49' 22.6" N	92° 59' 11.3" W	1.752	4301	2.435	6300	1999
AT2L	AT13 #2 Shell	2615	6997	901438.18940	10148521.86390	27° 56' 49.4" N	89° 17' 21.6" W	1.712	4203	2.100	5238	1035
AT1L	AT14 #1 BHP	2562	7064	904181.44430	10145035.55470	27° 56' 15.4" N	89° 16' 50.3" W	1.722	4228	2.100	5236	1008
AT1C	AT14 #1 BHP	2562	7064	904181.44430	10145035.55470	27° 56' 15.4" N	89° 16' 50.3" W	1.722	4228	2.100	5236	1008
AT2C	AT13 #2 Shell	2615	6997	901438.18940	10148521.86390	27° 56' 49.4" N	89° 17' 21.6" W	1.712	4203	2.100	5238	1035
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ATM1	AT14 #1 BHP	2556	7073	904551.77030	10144646.35110	27° 56' 11.62" N	89° 16' 46.09" W		4257			159
ATM2	AT14 #5 BHP	2556	7071	904470.29280	10144646.25410	27° 56' 11.6" N	89° 16' 47.0" W	1.715	4210	1.829	4505	99

Figure A1. Drill Site Location Map

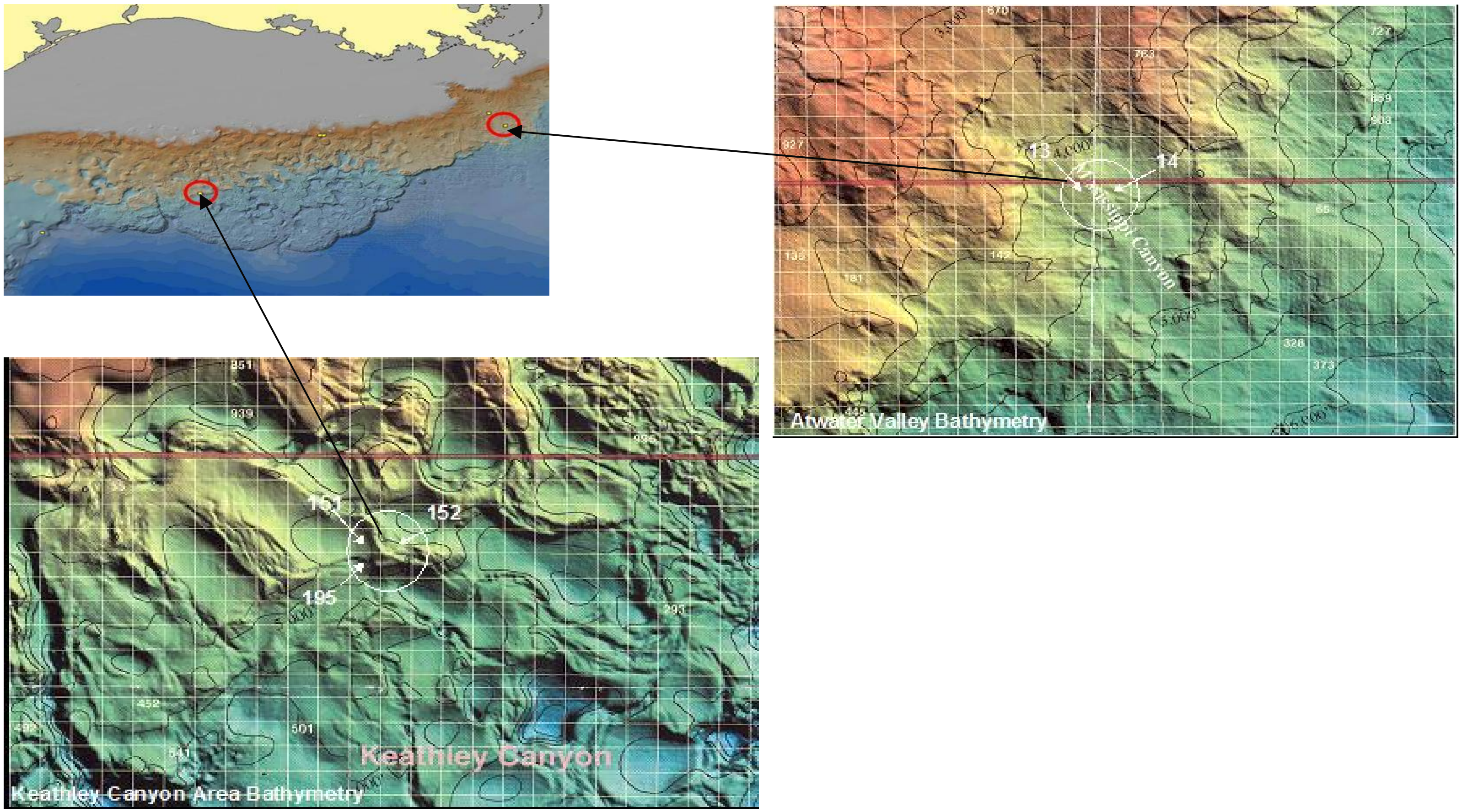


Figure A2. Atwater Valley Seismic Plot

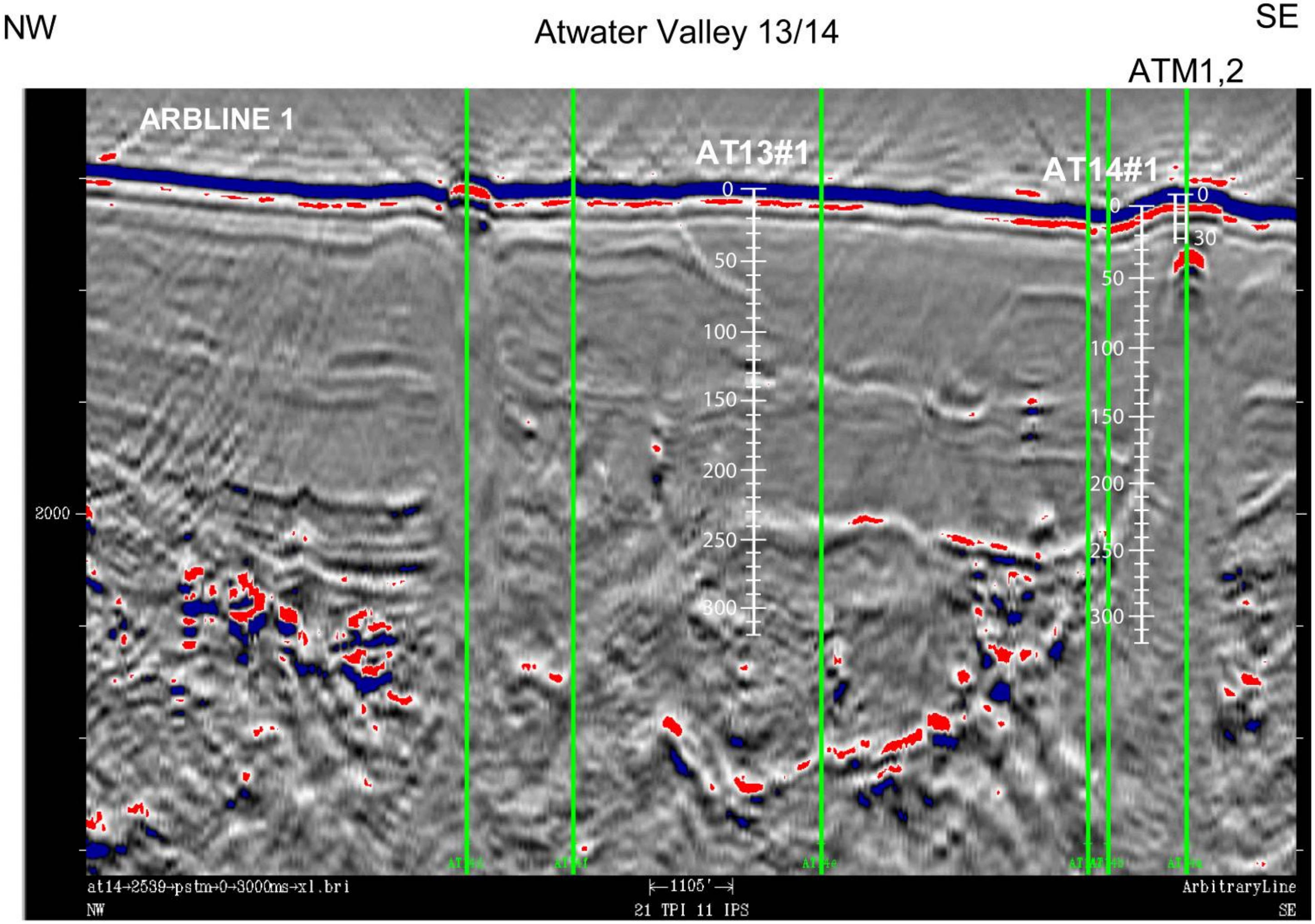


Figure A3. Keathley Canyon Seismic Plot

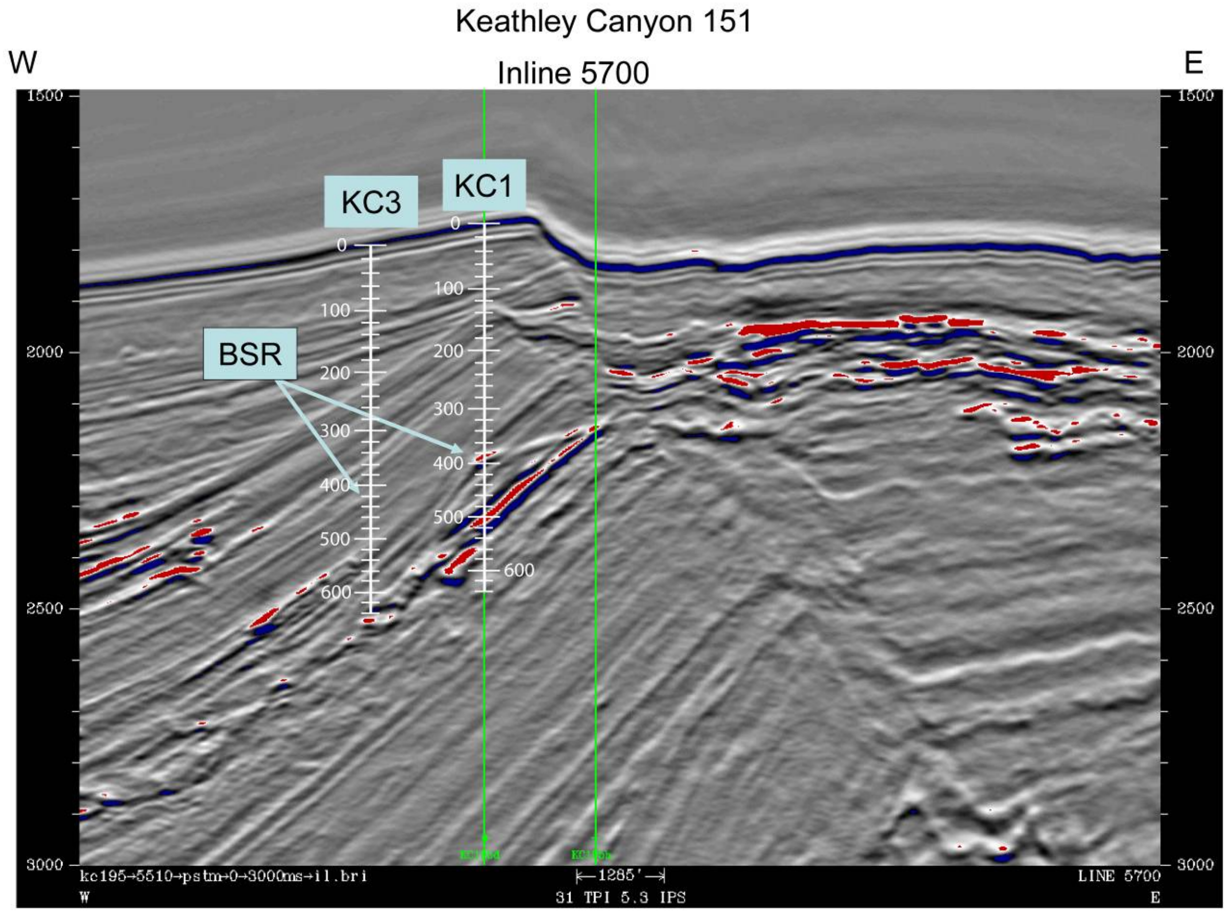


Table A2. Test Matrix

Test	Area	Specific test or value	Summary: Ship LP	Summary: Ship HP	Summary: Shore LP	Summary: Shore HP	Total
1	Mechanical	Stress-strain curves			3	1	4
2		Tensile strength			0	0	0
3		Shear Strength	1		2	1	4
4		Compressive strength			1	2	3
5		Young's moduli			2	1	3
6		Shear moduli			2	1	3
7		Bulk moduli			2	1	3
8		Poison's ratio			2	1	3
9		failure/stability envelopes			1	0	1
10		permeability			3	0	3
11		shear strength (minivane)	1		3	0	4
12		Triaxial Compression	1		1	0	2
13		Constraint modulus			1	0	1
14					0	0	0
15	Kinetics	Dissociation	1	1	1	1	4
16		Kinetic rate constants			0	0	0
17					0	0	0
18	Thermal	Thermal conductivity			4	1	5
19		Thermal diffusivity			0	0	0
20		Heat capacity			0	0	0
		IR imaging	1				
21					0	0	0
22	Seismic	P and S-wave velocities		1	1	2	4
23		acoustic impedance			1	1	2
24					0	0	0
25	Electrical	Resistivity		1	2	2	5
26		real permittivity at microwave frequencies			1	0	1
		magnetic susceptibility		1			
27					0	0	0
28	Geological	Distribution of hydrates within sediments			1	1	2
29		Pore filling			1	1	2
30		Pore Pressure		1	0	0	1

31		In-situ Temperature		1	0	0	1
32		Optical observation / analyses			1	0	1
33		Hydrate Type (Raman spectroscopy)			1	0	1
34					0	0	0
35	Formation Water	PH		1	3	0	4
36		Complete analysis			1	0	1
37		Pore water extraction		1	2	0	3
38		Electr. conductivity / ionic concentration			1	0	1
		Halogens, Ba, PO4					
39					0	0	0
40	Sediment Description	Chemical analysis			0	0	0
41		Grain size			3	0	3
42		water content			3	0	3
43		grain density			2	0	2
44		specific surface area			2	0	2
45		Density		1	2	0	3
46		Clay mineralogy			1	0	1
47		organic content			1	0	1
48	Gas analysis	C1-C5		1	2	1	4
49		C Isotope			1	1	2
50					0	0	0
51	Biological	Methanogens			0	0	0
		Clone library			0	0	0
52					0	0	0

Daily Science Reports

Daily Science Report for JIP GOM gas hydrates cruise, 18 April 2005

LOCATION: In transit from Mobile, AL to Atwater Valley Block 13

SCIENCE UPDATE: Science Party continuing work getting labs and core logging equipment ready to handle cores. Science meeting was held to plan core handling rehearsal, discuss meetings policy, and plan ROV sampling. Core handling teams will walk through operations in the core receiving van at 1400 hrs on Tuesday. Everyone should attend one of the pre-shift (1130 or 2330 hrs) safety meetings in the TV lounge each day. Science Party will hold daily information meeting at noon in the auxiliary dining hall. Attendance is optional. Members of ROV team joined science meeting to discuss ROV sampling plans and capabilities. Interested parties went up on deck for demonstration of coring tools and water sampling devices.

PLANS: Uncle John will arrive at the AV13 #1 site and be ready for operations by 2100 hrs this evening. The ROV will be used to take five short (50-60 cm) push cores and two 1-liter bottom water samples at the LWD hole location. One core each will be used for pore water chemistry, dissolved gas analysis, physical properties, microbiology, and archive.

Daily Science Report for JIP GOM gas hydrates cruise, 19 April 2005

LOCATION: On location Atwater Valley Block 13

SCIENCE UPDATE: First samples (ROV push cores of surface sediments and bottom water samples) were collected at proposed site of AT13#1 from 0345 to 0410 hrs this morning. The ROV was used for sampling while preparing to start the LWD hole. Only two of the five coring attempts had significant core recovery. Cores were sectioned and sampled for pore water chemistry and dissolved gas analysis. Initial results (alkalinity changes) indicate organic matter oxidation is ongoing, probably linked with sulfate reduction. There was no H_2S odor in the cores. These shallow push cores are ancillary to the main deep coring program, but provide a valuable exercise and trial for our core handling and analytical procedures, as well as information on sediments at the seabed..

PLANS: Core handling teams conducted a review/rehearsal of core processing procedures on Tuesday afternoon. Continuing to set up and calibrate equipment while waiting for completion of LWD holes to begin coring.

Daily Science Report for JIP GOM gas hydrates cruise, 20 April 2005

LOCATION: On location Atwater Valley Block 13

SCIENCE UPDATE: Logging scientists busy collecting and interpreting real-time pulsed data on currently drilling AV13#1 LWD hole. Core handling teams reviewed procedures and job assignments for processing and sampling FHPC/FC (nonpressurized) cores. Others in science party continued setting up and calibrating lab equipment.

PLANS: Night shift core handling team will go through dry run of core processing procedures on empty core liner. Science meeting tomorrow will cover handling of pressurized cores and protocols for distribution and preservation of any hydrate samples recovered in nonpressurized cores.

Daily Science Report for JIP GOM gas hydrates cruise, 21 April 2005

LOCATION: On location Atwater Valley Block 14

SCIENCE UPDATE: AV13#1 LWD hole was terminated at a depth of 261 meters beneath the sea floor. Preliminary analysis of the pulsed log results indicates some zones of possible hydrate occurrence. Uncle John moved to location of proposed LWD hole AT14#1. Attempt at ROV push coring of shallow sediments while setting the beacons was unsuccessful. Topics at daily science meeting included a review of AV13#1 preliminary log results and a discussion of strategies for shipboard pressure core experiments. The gas chromatograph has been installed and calibrated, and was used for headspace gas analysis of sediment from one of the shallow push cores taken at AV13#1. Besides air gases, the samples contained only small amounts of carbon dioxide. Methane and hydrogen sulfide were below detection levels.

PLANS: Interpret logs on AV14#1 in context of seismic data to plan core coverage and other measurements for proposed AV13#2 hole.

Daily Science Report for JIP GOM gas hydrates cruise, 22 April 2005

LOCATION: On location Atwater Valley Block 14

SCIENCE UPDATE: ROV push cores of surface sediments and bottom water samples were recovered at the AT14#1 site, after an unsuccessful first attempt. Additional ROV time was available while waiting for currents to subside to start the AT14#1 LWD hole. The ROV camera showed evidence of seepage on the seafloor around AT14#1, with probable microbial mats and possible patches of carbonate and black sulfides. Two full (20-30 cm) cores and one partial core were recovered. The longer core was divided into three sections for geochemical analysis. The entire core appeared to have gas expansion features, and the top section (0-10 cm) smelled slightly of hydrogen sulfide. Salinity was 44.5 ppt near the surface and increased to 52 ppt in the deeper (20-35 cm) section. Dissolved sulfate was depleted, with 4.7 millimolar concentration in the uppermost section, and only 0.2 mM at 20-35 cm. The plan the for proposed AT13#2 coring well was updated in light of the preliminary LWD results. Seismic amplitude anomalies appeared to coincide with regions of lower resistivity. Proposed coring intervals will target these zones

PLANS: Set up the Core Processing Van to be ready for full cores by Sunday. Need designated places for the required equipment (wiping rags, core cutters, endcaps, wire saws, spatulas, gas sampling syringes and vials, thermometers, buckets, Al foil, sample bags, liquid nitrogen containers, and hydrate pressurization containers). Update coring program for proposed AT14#2 when preliminary LWD results are available.

Daily Science Report for JIP GOM gas hydrates cruise, 23 April 2005

LOCATION: On location Atwater Valley Block 14

SCIENCE UPDATE: No new results, waiting on data from LWD well. Unpacked and distributed special protective equipment of handling hydrate cores (Kevlar aprons, face shields). A gas hydrate sampling and storage plan was developed and implemented. Cold spots indicated by IR scan will be cut out as whole rounds, and samples of gas hydrate extruded during core handling will be stored in Parr pressure vessels or in liquid nitrogen dewars. Appropriate bags and labels are on hand.

PLANS: Continue getting ready for cores on Sunday.

Daily Science Report for JIP GOM gas hydrates cruise, 24 April 2005

LOCATION: Moving from Atwater Valley Block 14 back to Block 13

SCIENCE UPDATE: Logging Scientist has provided the science party with a preliminary interpretation of the LWD results from AT14#1. The caliper log shows good to very good hole conditions, with some breakouts or washouts in the deeper part of the hole. The gamma-ray log indicates clay-dominated muds with no sands. Porosities from density are high, with no consistent trends. Resistivity logs are very good, with no obvious indications of gas hydrates. There is a shift to lower resistivity values at the approximate depth (200 mbsf) of the penetration of the side of the diapiric feature underlying Mound F near AT14#1. This could indicate low concentrations disseminated gas hydrate or free gas.

PLANS: First FHPC core is expected tomorrow AM. Making final preparations to receive, process, sample and store cores.

Daily Science Report for JIP GOM gas hydrates cruise, 24 April 2005

LOCATION: On location Atwater Valley Block 13

SCIENCE UPDATE: Moved from AT14 to AT13. We revised the coring plan for AT13#2 after reviewing all of the LWD results. The plan now is to core intervals 0-45, 115-152, and 220-257 meters beneath the sea floor. This will require 16 FHPC nonpressurized cores and 7 FHC/HRC pressurized. The revised coring plan was based on reinterpretation of the full suite of LWD logs, with focus on the mid-depth range (115-152 mbsf) amplitude anomaly, interpreted as possible gas hydrate-cemented mud, overlain by carbonate cemented mud.

PLANS: Expect first core this evening about 0200 hrs.

Daily Science Report for JIP GOM gas hydrates cruise, 26April 2005

LOCATION: On location Atwater Valley Block 13#2

SCIENCE UPDATE: Due to mechanical problems with coring systems at AT13#2, only three cores were obtained and processed by 1400 hrs today. Next core should arrive by 1600 hrs. Core AT13#2 1H was a full 7 meter FHPC core with no gas expansion or obvious cold spots by IR. Each of the 1-m sections was sampled for pore water chemistry, and three of the sections sampled for headspace gas analysis. Preliminary results indicate that core 1H spans most of the sulfate reduction zone, with very faint H2S odor in the bottom section. Pore water salinity is that of normal seawater. Core AT13#2 -2H was an 8.5 m FHPC core with visible gas expansion voids near the bottom of the core. The gas was relatively pure methane (99%) with minor CO2 (1%) and ethane (<50 ppm) after correction for air contamination. MSCL logging of 1H shows P-wave velocity near 1500 m/s consistent with high porosity stiff clay. No major lithologic changes are evident in the MSCL logs. MSCL logging of core 2H was difficult for P-wave due to gas expansion cracks and voids. The third core was an FPC pressure core that overshot and prevented proper valve sealing at subsurface pressure. A full 1-m core was recovered as AT13#2-3P and will be processed as a regular non-pressurized core.

PLANS: Continue with coring at AT13#2. Plan is to continuously core depth intervals 0-45m, 115-152m, 220-257m. Two more pressure cores will be deployed in the upper coring interval, and two each in the lower intervals for a total of seven. Five temperature measurements were planned, the first attempt at a depth of 15.5 mbsf was only partially successful. One piezoprobe measurement is planned deeper in the hole.

Daily Science Report for JIP GOM gas hydrates cruise, 27April 2005

LOCATION: AT13#2

SCIENCE UPDATE: Coring activity picked up yesterday, with four cores recovered between 1600 and 2000 hrs. Two nonpressurized (4H and 6H) cores were processed, sampled and logged. Two pressurized cores (5R and 7P) successfully recovered sediment, but were only partially successful in retaining pressure. The valve on the Hyacinth rotary core (5R) did not close properly. The Fugro rotary core retained subsurface pressure, but could not be successfully transferred. Adjustments are being made and both tools are expected to function properly in future deployments. The nonpressurized (FHPC) cores (4H and 6H) contained abundant gas with numerous expansion gaps in the core liner, but no observable evidence of gas hydrate or no cold spots when imaged by IR. Gas samples from the cores were analyzed and contained relatively pure methane (99%) with increasing amounts of ethane (up to 180 ppm). These ethane levels are greater than would be expected in microbial methane at such shallow depths (36 mbsf), and probably indicate some input of migrated thermogenic gas.

PLANS: Coring was interrupted just before midnight by an electrical malfunction in the top drive, which is not expected to be repaired until after 1700 hrs today. When we resume coring we will take one more FHPC core to a depth of about 44 mbsf, and then wash down without coring to a depth of 117 mbsf. The depth interval between 117 and 153 mbsf contains the most interesting indications of possible gas hydrate occurrence at this location, both from the seismic records and the LWD data.

Daily Science Report for JIP GOM gas hydrates cruise, 28 April 2005

LOCATION: AT13#2

SCIENCE UPDATE: A nonpressurized core (8H) was recovered last night (2100 hrs) from the depth interval 40-48 meters beneath the sea floor. The core liner contained several expansion gaps filled with gas, but no evidence of gas hydrate. The gas was mainly methane with minor CO_2.

PLANS: Coring was interrupted just before midnight by an electrical malfunction in the top drive, which is not expected to be repaired until after 1700 hrs today. When we resume coring we will take one more FHPC core to a depth of about 44 mbsf, and then wash down without coring to a depth of 117 mbsf. The depth interval between 117 and 153 mbsf contains the most interesting indications of possible gas hydrate occurrence at this location, both from the seismic records and the LWD data.

Daily Science Report for JIP GOM gas hydrates cruise, 29 April 2005

LOCATION: AT13#2

SCIENCE UPDATE: The HRC pressurized coring tool deployed last night as core 10R failed to capture a core. A nonpressurized core (11H) was recovered at about midnight from the depth interval 126-134 meters beneath the sea floor. Core 11H (similar to 9H) also shows a different fluid chemistry than the shallower (0-45 m) section cored earlier, with lower salinity and gas content. The seismic amplitude anomaly targeted at 120-130 mbsf was shown by core logging and X-ray imaging of core 11H to be a distinct density contrast caused by a change in lithology.

Coring was interrupted again by electrical problems in the drilling systems, and was resumed this morning with deployment of the FPC tool as core 12P. The FPC barrel separated and stuck at the bottom of the hole. The lower half of the FPC tool was successfully fished out by 1300 hrs today.

PLANS: Coring is starting again with two consecutive FHPC cores (13H, 14H) one temperature measurement, and a deployment of the piezoprobe (core 15PI) at the base of the 119-153 mbsf cored interval. Following this the hole will be deepened to 200 m where a final FHPC core (16H) will be attempted before beginning the wireline logging program.

Daily Science Report for JIP GOM gas hydrates cruise, 30 April 2005

LOCATION: AT13#2

SCIENCE UPDATE: Partial FHPC cores were obtained as 13H and 14H over the depth interval 141 to 158 m. Full cores were collected but were jammed in the core barrel so only 2-3 m could be removed from each end. The hole was drilled down to about 200 m to begin the wireline logging program. Shipboard logging and geochemical analyses of cores have been completed on all AT13#2 cores collected to date. Several samples have been analyzed by Fugro for geotechnical properties. The cored intervals at AT13#2 will serve as a reference section for comparison with sediments to be cored at AT14#2 and on the adjacent mound. X-ray imaging of the cores enables a visual determination of the depth of the sulfate-methane interface. Dissolved methane begins to increase in concentration at the depth where sulfate is eliminated from the pore water. When the cores are brought to the surface the methane comes out of solution and causes visible small cracks and partings in the sediment. There is a distinct boundary at the base of AT13#2 core 1H showing the transition to gas containing sediment, which corresponds to the depth of the SMI as indicated by geochemical measurements.

PLANS: Finish wireline logging of AT13#2. Move to AT14#2 and core the upper 30 m (3 FHPC nonpressurized cores, 1 FPC/HRC pressure core). Wash down to the 80-100 m interval and take two FHPC cores. Wash down again to the 170-230 m interval and core across the boundary of the intrusive feature on the seismic record. Drill down to 280 m and run wireline logs. Move to top of

Mound and take three FHPC cores, 2 FPC/HRC cores down to 30 m. Try to do the above by May 8 and move to Keathley Canyon.

Daily Science Report for JIP GOM gas hydrates cruise, 1 May 2005

LOCATION: AT13#2

SCIENCE UPDATE: Unable to carry out wireline logging at AT13#2 due to inability to run logging tools out of pipe and hole collapse. The move to AT14 is delayed because of problems with seabed frame. Reports on core logging and physical properties were presented at daily science meeting. Multi-sensor core logger (MSCL) records (P-wave, gamma, magnetic susceptibility, and temperature) of AT13#2 cores were reviewed. As with X-ray, P-wave logging is also very sensitive to the transition from gas-free to gas-containing sediments. Temperature monitors mounted in core processing van provide continuous record of ambient van temperatures, as well as core temperatures during processing. Records to date indicate need for improvements in both core handling and van cooling system to properly process and conduct planned experiments on any recovered gas hydrates. Modifications to the cooling system are underway. The Fugro shipboard lab is providing measurements of geotechnical properties. Bulk density and undrained shear strength were measured on specimens from 3 to 48 mbsf at Site AT13#2. The bulk density is 1.55 g/cm3 at the seafloor, and ranges from 1.6-1.62 g/cm3 over the interval 8-32 mbsf, and then gradually increases to 1.68 g/cm3 by 48 mbsf. Miniature vane and Torvane tests document a linear increase in undrained shear strength downhole to a maximum of 32 kPa at 48 mbsf. The increase in strength is attributed to the increase in density and decrease in porosity with increasing depth.

PLANS: Plans remain the same—move to AT14#2 and begin coring as soon as possible.

Daily Science Report for JIP GOM gas hydrates cruise, 2 May 2005

LOCATION: AT13#2

SCIENCE UPDATE: No new results, waiting on seabed frame repair and deployment. Some gas samples from AT13#2 were taken to labs at USGS Menlo Park by an early returning member of the Science party. When these samples were analyzed on a more sensitive gas chromatograph, they gave comparable results except for the detection of very small amounts (1-2 ppm) of propane and traces of butanes, which were not detected on the less sensitive shipboard GC.

PLANS: Plans remain the same—move to AT14#2 and begin coring as soon as possible.

Daily Science Report for JIP GOM gas hydrates cruise, 3 May 2005

LOCATION: AT13#2

SCIENCE UPDATE: After reviewing objectives in light of the remaining cruise schedule, the Science Party recommended coring on mound F instead of at proposed AT14#2. We should be at mound site ATM1 (27°56’11.62”N, 89°16’46.09”W) by 18:00 hrs tonight, and ready to core shortly after. After shallow (<30 m) coring on the mound, we will leave the Atwater Valley area by 07:00 on 5/6/05 and transit to Keathley Canyon.

PLANS: Core ATM1, depending on results either core a second mound site or proceed to Keathley Canyon.

Daily Science Report for JIP GOM gas hydrates cruise, 4 May 2005

LOCATION: AT14 Mound Sites

SCIENCE UPDATE: The depth interval 0-29 mbsf was cored at mound site ATM1 (27°56’11.62”N, 89°16’46.09”W) with three FHPC cores and three FPC or HRC pressure cores. The FHPC cores recovered a total of 21 meters of sediment. The pressure cores in some cases recovered sediment, but did not retain subsurface pressure. The FHPC cores contained gas–relatively pure methane (98.6-99%) with traces of ethane (40-170 ppm) and minor CO_2 (1-1.4%). The apparent gas content (based on core voids and pressure) was at a maximum in core ATM1-2H and declined with increasing depth in core ATM1-5H. Pore water removed from the core had salinity of 56 ppt in core ATM1-1H, which declined to 51.5 ppt in the upper part of core ATM1-2H, then increased back to 56 ppt at the bottom of core 5H. The salinity variation has the appearance of localized dilution by fresh water, which could be due to gas hydrate decomposition. Additional analyses are underway and planned to test this possibility.

PLANS: Core upper 29 m at the second mound site ATM2 (27°56’11.60”N, 89°16’47.0”W), leave the Atwater Valley area by 23:00 on 5/5/05 and transit to Keathley Canyon.

Daily Science Report for JIP GOM gas hydrates cruise, 5 May 2005

LOCATION: In Transit from Atwater Valley to Keathley Canyon

SCIENCE UPDATE: The depth interval 0-29 mbsf was cored late Wednesday and early Thursday at mound site ATM2 (27°56’11.60”N, 89°16’47.00”W). Three FHPC cores were taken in the upper portion followed by two HRC pressure cores and a final FPC pressure core near the base of the cored section. The FHPC cores recovered sediment from the upper 24 meters beneath the seafloor. The pore waters showed a similar pattern of salinity variation as the cores from the ATM1 site. IR imaging showed that colder zones of the cores frequently coincided with gas expansion voids. Closely spaced samples for pore water chemistry were collected adjacent to these cold zones to test for pore water freshening. Salinities were lowest just next to, and increased with distance away from the cold zones. These observations are consistent with gas hydrate having been present in the sediment and decomposing prior to sampling. The two deeper HRC pressure cores did not recover any sediment. The FPC pressure core recovered sediment from 27-28 meters under pressure. This pressurized core (ATM2-6P) was successfully transferred to an aluminum storage chamber, and 2D X-ray images show discrete zones of low-density (about 1 g/cc) material in the core. More detailed analysis of 3D CT imaging is currently in process. The core is being maintained in stable condition while improvements are being made on the cold van to create an environment in which the full array of shipboard experiments on pressurized cores can be conducted.

PLANS: Continue working up results from the previous three coring sites in Atwater Valley and refine the LWD, coring and wireline logging plans for KC151 #1 and #2.

Daily Science Report for JIP GOM gas hydrates cruise, 6 May 2005

LOCATION: In Transit from Atwater Valley to Keathley Canyon

SCIENCE UPDATE: The successfully collected and transferred pressurized core ATM2-5P (note that core number is corrected from yesterday's report) was logged with the vertical gamma-ray logger, which provided a 1-D gamma density profile of the core through the aluminum storage chamber. The presence of the low density material imaged by X-ray CT scan was confirmed by the gamma logger. Further calibration is needed to express the density measurements more quantitatively. The core will be maintained in stable condition while improvements are being made on the cold van. Discussions are ongoing concerning the sequence of experiments to be conducted.

PLANS: Rework the time estimates and the coring program for the new, adjusted schedule.

Daily Science Report for JIP GOM gas hydrates cruise, 7 May 2005

LOCATION: Keathley Canyon Block 151

SCIENCE UPDATE: The transit was completed this morning and preparations for LWD hole are underway. Shallow (1 meter) push cores were collected by the ROV while beacons were being deployed. The cores appeared to be oxidized red-brown mud in the uppermost 15-20 cm, with typical green-grey mud below. Preliminary analyses of sediment fluids show seawater salinity and no dissolved methane.

PLANS: Wait for LWD results to adjust coring plans.

Daily Science Report for JIP GOM gas hydrates cruise, 8 May 2005

LOCATION: Keathley Canyon 151 #1

SCIENCE UPDATE: KC151#1 LWD hole spudded this morning and is drilling ahead as planned (140 mbsf by 1700 hrs). LWD response is consistent with an expected seismic feature (unconformity) and a 5-m thick sand. Sediments at Keathley Canyon are more compacted than those in Atwater Valley. Porosity has decreased to 50% at a depth of 100 mbsf. The pressurized core ATM2-5P was further investigated by degassing while scanning in the MSCL-V. Gas and liquid samples are being collected for analysis during the degassing.

PLANS: Review LWD results and adjust or refine KC151#2 coring plan.

Daily Science Report for JIP GOM gas hydrates cruise, 9 May 2005

LOCATION: Keathley Canyon 151 #1

SCIENCE UPDATE: KC151#2 LWD hole (note required name change to MMS permit designation) TD'd at 459 mbsf at about 2100 hrs. Logs show 85-m thick (215-300 mbsf) mudrock zone with several low resistivity or possible gas hydrate intervals. Only a small resistivity spike was noted at the depth of the seismic BSR (385-393 mbsf).

PLANS: Reallocate planned coring intervals for KC151#3 hole to provide adequate coverage of possible gas hydrate zones.

Daily Science Report for JIP GOM gas hydrates cruise, 10 May 2005

LOCATION: Keathley Canyon 151

SCIENCE UPDATE: Drill pipe and logging tools were removed from KC151#2 LWD hole by 19:00 hrs. The sea bed frame and coring bottom hole assembly will be made up and lowered on the drill pipe to position on the sea floor for coring. Coring could begin by 19:00 hrs on 11 May at the earliest. Additional results on the ATM2-5P pressure core degassing experiment were reported at the Daily Science meeting. The volume of methane obtained was 1.02L. Preliminary calculations suggest that this amount of methane would produce about 1% levels of gas hydrate saturation in the pore space, which is inadequate to explain inferred volume of low density material indicated by the core logging. Extruded sediment was sectioned and expressed pore waters analyzed. If the lower salinity pore water from the approximate location of the low density core material was due to fresh water dilution from gas hydrate decomposition, it suggests that gas hydrate saturation was on the order of 6% of pore space.

PLANS: The science party recommended a revised plan to focus coring in the intervals 0-45, 100-120, 210-295, 380-405, and 440-458 mbsf in hole KC151#3.

Daily Science Report for JIP GOM gas hydrates cruise, 10 May 2005

LOCATION: Keathley Canyon 151

SCIENCE UPDATE: The first FHPC core from the KC151#3 borehole arrived on deck at 15:20 hrs. Cores 1H, 2H, 3H and 4H spanned the depth intervals 0-7.1, 9.4-17.2, 18.6-26.45, and 27.7-35.6 mbsf, respectively. Distinct H2S odors were present near the bottom of core 1H. The sulfate-methane interface appears to be at a depth of about 9 mbsf, or between cores 1H and 2H. Salinities increase from 35 ppt near the seafloor to about 40.5 ppt near the bottom of core 2H. The first temperature measurement was made at the bottom of core 3H, but the data has not yet been downloaded and interpreted.

PLANS: Continue coring down to a depth of about 45 mbsf, then wash down to a depth of 100 mbsf. Resume coring just above an unconformity capped by a 5-m thick water-bearing sand layer. Continue coring through and beneath the unconformity to a depth of about 120 mbsf, taking two pressure cores within this interval. Wash down to 200 mbsf and resume coring in the interval shown by LWD to be potentially gas hydrate-bearing.

Daily Science Report for JIP GOM gas hydrates cruise, 12 May 2005

LOCATION: Keathley Canyon 151 #3

SCIENCE UPDATE: After drilling down (without coring) from 45 to 100 mbsf, a 3.8 m core was collected with the Fugro corer (FC). Following this core (6C), an FPC pressure core barrel was deployed and became stuck at the bottom of the drill pipe. Coring will resume tomorrow after the drill pipe is brought up to remove the stuck core barrel and then lowered again. The sulfate-methane interface in KC151#3 was at a depth of about 9.4 mbsf, between cores 1H and 2H. Alkalinity increases down to, and decreases beneath the SMI, with trends that converge at a maximum of about 17 mM, but the exact alkalinity maximum was not observed. Residual methane content (estimated from headspace technique) increases to about 10 mM at a depth of 11.1 mbsf (about 1.7 m beneath the SMI.) giving a gradient of about 6 mM/m, which is equal (but opposite in sign) to the inferred sulfate gradient. This observation (and the approximate 1:1 relationship between sulfate depletion and alkalinity addition) is consistent with sulfate reduction being driven by anaerobic oxidation of upwardly transported of methane.

PLANS: Wash down to 200 mbsf and resume coring in the interval shown by LWD to be potentially gas hydrate-bearing.

Daily Science Report for JIP GOM gas hydrates cruise, 13 May 2005

LOCATION: Keathley Canyon 151 #3

SCIENCE UPDATE: KC151#3 is currently drilling down in to a depth of 210 mbsf where coring will resume (sometime after 0100 hrs on 14 May). The Fugro Corer (FC) tool will be used to recover 5.1-m cores in the more compacted muds expected at these depths. Six pressure cores will be attempted in five of the six high resistivity intervals logged between 220 and 300 mbsf. Imaging of core KC151-3-2H showed High-density layers/nodules just beneath the sulfate-methane interface. Samples will be analyzed post-cruise to determine if these layers are authigenic carbonates precipitated from the dissolved bicarbonate formed by anaerobic methane oxidation.

PLANS: Wash down to 210 mbsf and resume coring in the interval shown by LWD to be potentially gas hydrate-bearing.

Daily Science Report for JIP GOM gas hydrates cruise, 14 May 2005

LOCATION: Keathley Canyon 151 #3

SCIENCE UPDATE: Four cores were successfully collected over the depth interval of 210-230 mbsf in KC151#3 between 07:30 and 21:00 hrs on Saturday. The last core (KC151#3-11P) was an FPC core recovered with 145-150 bar pressure (just under hydrostatic for depth of 1562 mbsl). The pressure core was successfully transferred to an aluminum storage chamber and is currently undergoing a series of nondestructive tests. The core was from an interval previously shown by LWD data to have high resistivity, possibly caused by gas hydrate cementation. Cores collected earlier in this same interval (KC151#3-7C, -8C, -10C) were stiff gray muds with high salinity pore water (50 ppt) and low apparent gas content at the surface.

PLANS: Continue coring down to 300 mbsf with eight FC cores, four pressure cores, two temperature measurements, and one piezoprobe deployment.

Daily Science Report for JIP GOM gas hydrates cruise, 15 May 2005

LOCATION: Keathley Canyon 151#3

SCIENCE UPDATE: The Fugro Pressure Core (11P) that was successfully brought up and transferred under pressure did not show any evidence for gas hydrate by core X-ray imaging or logging. Core 11P is undergoing a full range of experiments (Vp, Vs, resistivity, strength) with the MSCL-P (pressurized multi sensor core logger with central measurement chambers) to provide information on differences in physical properties between pressurized and nonpressurized cores. Seven more coring runs were made over the depth interval 230-265 mbsf in KC151#3 during the last 24 hrs. Cores 12C and 14C recovered the usual stiff gray mud with high salinity pore water (50 ppt) and low apparent gas content at the surface. The Hyacinth Rotary pressure core tool (HRC) recovered a partial core under pressure that was successfully transferred, imaged and logged. Core 15C contained the first distinct cold spot detected by the IR camera. The 10-cm whole round section with the cold spot was immediately cut out and placed in liquid nitrogen. The core material adjacent to the cold spot had the disturbed, mousse-like texture that is characteristic of sediment with decomposed gas hydrate. A pore water sample from immediately below the cold spot did not have lowered salinity, nor was the residual headspace gas content of the core above normal background levels. The IR-imaged cold spot and the mousse-like core texture are strong evidence for at least the former presence of gas hydrate. However, we have been unable to develop any additional confirming evidence for gas hydrates at the present time. Core 16C was an empty core barrel. An FHPC core (17H) recovered about 5 meters of sediment with several gas voids retained (core gas appears to be lost when using the FC coring tool).

PLANS: Take one pressure (FPC) core (18P) at 266 mbsf, then alternate coring and drilling with each pipe joint down to 380 mbsf. At 380 mbsf, start continuously coring through the depth corresponding to the seismic BSR (385 mbsf) to 405 mbsf, with pressure cores above and below the depth of the BSR.

Daily Science Report for JIP GOM gas hydrates cruise, 16 May 2005

LOCATION: Keathley Canyon 151#3

SCIENCE UPDATE: Fugro Pressure Core (18P) collected a core but it was not under pressure due to a broken liner. Cores 19H and 20H were 8-m FHPC cores that retained gas voids and permitted gas sampling. Core 21H appeared to have reached the penetration limit for the hydraulic piston core, recovering only about 2.5-m of core. Core 22C was a 3-m core obtained with the Fugro Corer. None of these cores had cold spots when imaged by the IR camera, although cores 19H and 20H had significant gas expansion.

PLANS: Continue drilling down with coring every second pipe joint down to 380 mbsf. At 380 mbsf, start continuously coring through the depth corresponding to the seismic BSR (385 mbsf) to 405 mbsf, with pressure cores above and below the depth of the BSR.

Daily Science Report for JIP GOM gas hydrates cruise, 17 May 2005

LOCATION: Keathley Canyon 151#3

SCIENCE UPDATE: Cores 23C, 24C, and 25C taken with the FC core barrel had low recoveries of disturbed sediment. Core 26R was a pressure core taken with the Hyacinth Rotary Corer at or just above the depth of the BSR (383 mbsf) which came up with 140 bar pressure and was successfully transferred. Core 27P was an unsuccessful attempt to get a pressure core just below the BSR.

PLANS: Take an FC core with a temperature measurement as Core 27C at 387 mbsf, then follow with an HRC pressure core and a piezoprobe measurement. Drill down to 440 mbsf and take FC core if time permits. Otherwise condition hole and make ready for wireline logging.

Daily Science Report for JIP GOM gas hydrates cruise, 18 May 2005

LOCATION: Keathley Canyon 151#3

SCIENCE UPDATE: Coring was completed in the KC151#3 hole today and preparations for logging were begun. Core 27C returned an empty core barrel. The HRC pressure core attempted as Core 28R was unsuccessful, as was the attempt at piezoprobe insertion. With time running out, the hole was deepened to 440 mbsf and prepared for logging. Core 26R, the HRC pressure core was quantitatively degassed after a full suite of nondestructive logging and imaging experiments. The core was 51 cm in length with minor low-density layers but no obvious indications of gas hydrate. Preliminary results of the degassing experiment suggest that the methane content of the pore water was about saturated with respect to methane hydrate.

PLANS: Start wireline logging and VSP (vertical seismic profile) experiment. Pack up lab equipment and samples, prepare for shipping to various locations at the conclusion of the cruise on Sunday.

Daily Science Report for JIP GOM gas hydrates cruise, 19 May 2005

LOCATION: Keathley Canyon 151#3

SCIENCE UPDATE: Wireline logging and VSP programs were carried out over the 120-342 mbsf interval in the KC151#3 hole today. Logs showed high velocity intervals that correlate with the high resistivity intervals in the KC151#2 LWD hole. The VSP shot 108 stations over about the same depth interval. The hole was abandoned with a cement plug and the drill string and sea bed frame are being picked up during the night. Another HRC pressure core (13C) was degassed, yielding about 7.3 L of gas. The shipboard gas chromatograph was down, and the gas composition will be determined later in a shore-based lab. The core was 60 cm in length in a 1-m core barrel, with the balance filled with water. The core will be opened and further analyzed to determine porosity and other physical properties. If the gas was 75% methane (with the balance air) and the porosity of the core 50%, then the amount of methane in excess of that which could be dissolved in the water requires that an average of about 3% of the pore space in the recovered pressure core was occupied by methane hydrate.

PLANS: Pack up lab equipment and samples, prepare for shipping to various locations at the conclusion of the cruise on Sunday.

APPENDIX B. Drilling

Table B1. Precruise Drilling Time Table

		Base Case (2 KC + 2 AT + 2 mounds @ AT)		
	Activity	**Depth (m-MD)**	**Task Time (hr)**	**Cumulative Time (d)**
AT #2L	Move rig to Atwater Valley 14	0	33.0	1.4
	Position Rig on location in A.V. Establish position. RIH w/ LWD assembly	1,281	24.6	2.4
	Drill 8 1/2" hole with LWD tool string to 315m BML (~1600m MD)	1,600	16.3	3.1
	Sweep hole & POOH above mudline	1,600	3.9	3.2
	POOH to surface & L/D BHA			3.2
	RIH & set cement plugs			3.2
	POOH with cmt stinger			3.2
	M/U LWD BHA. RIH to mudline			3.2
AT #1L	Reposition Rig to next location in A.V. Set sea bed frame	1,289	4.4	3.4
	Drill 8 1/2" hole with LWD tool string to 307 m BML (~1599 m MD)	1,599	15.8	4.1
	Sweep hole & POOH back to surface. L/D LWD tools.	1,599	22.7	5.0
AT #1C	Position on Location & prep for coring; RIH to mudline; Core top 90'	1,289	18.9	5.8
	Begin drilling & spot coring (10m per 30 m) with FHPC to 183m BML	1,472	16.1	6.5
	Take 7 pressure cores	1,472	9.6	6.9
	Take 15' samples from 183- 244 m BML; Drill to TD at 1599 m MD	1,599	15.4	7.5
	In-situ temperatures	1,599	3.3	7.7
	Take 3 Piezoprobe tests	1,599	14.0	8.2
	Circ, ream cored hole, POOH to mudline, R/U wireline	1,599	5.5	8.5
	Log open hole with DSI. Pull DP above mudline	1,599	14.3	9.1
Mound Cores	Move to mound & establish position for surface cores	0	4.4	9.3
	Take 2 ea FHPC & FPC cores & in-situ temps	0	11.1	9.7
	Move to next mound & repeat 2 FHPC & 2 FPC & temps	0	13.3	10.3
	Move to next mound & repeat 2 FHPC & 2 FPC	0	0.0	10.3
AT#2C	Position on Location & prep for coring; RIH to mudline; Core top 90'	1,281	7.4	10.6
	Drill & spot core down to 244 m BML.	1,525	23.3	11.6
	Take 30' samples from 244m to 315 m BML	1,600	9.6	12.0
	Take 7 pressure cores	1,600	9.6	12.4
	In-situ temperatures	1,600	2.1	12.4
	Take piezoprobe test at TD	1,600	3.6	12.6
	Circ, ream cored hole, POOH to mudline; R/U wireline	1,600	5.5	12.8
	Log open hole with DSI & VSP. Pull DP above mudline	1,600	30.8	14.1
	POOH & L/D core assembly; Ballast Up	1,600	16.9	14.8
KC #3L	Move from AT 14 to KC 151 sites	0	36.7	16.3
	Position on Location & prep for drilling; RIH to mudline	0	25.0	17.4
	Drill 8 1/2" hole with LWD tool string to 553 m BML (~1887m MD)	1,333	28.5	18.6
	Sweep hole & POOH above mudline	1,890	3.3	18.7

KC #1L	Reposition Rig to next location in K.C. Set sea bed frame	1,311	4.4	18.9
	Drill 8 1/2" hole with LWD tool string to 609 m BML (~1920 m MD)	1,920	31.4	20.2
	Sweep hole & POOH to surface with LWD tools. L/D same.	1,920	17.7	20.9
KC #1C	Position on Location & prep for coring; RIH to mudline; Core top 90'	1,311	30.0	22.2
	Begin drilling & spot coring with FHPC to 361m BML	1,672	40.1	23.9
	Take 7 pressure cores	1,672	9.6	24.3
	Take 15' samples from 361-422 m BML (30m +/- BSR) & drill to TD at 1923 MD	1,923	31.2	25.6
	In-situ temperatures	1,923	4.2	25.7
	Take total of 3 Piezoprobe tests	1,923	14.0	26.3
	Circ, ream cored hole, POOH to mudline	1,923	11.0	26.8
	Log open hole with DSI & VSP. pull DP above mudline	1,923	33.0	28.2
KC #3C	Position on Location & prep for coring; RIH to mudline; Core top 90'	1,333	7.4	28.5
	Drill & spot core (60' per 200') to 410m BML	1,743	43.0	30.3
	Take 7 pressure cores	1,743	9.6	30.7
	Take 15' samples from 410-471m BML; Drill to TD at 1890m	1,890	26.4	31.8
	In-situ temperatures	1,890	4.6	31.9
	Take Piezoprobe tests	1,890	3.6	32.1
	Circ, ream cored hole, POOH to mudline, pull center of bit	1,890	7.7	32.4
	Log open hole with DSI	1,890	13.2	33.0
	POOH & L/D core assembly; Ballast Up	1,890	17.3	33.7
	Demobilize to Mobile	0	33.0	35.1

Figure B1. Core Handling

Core Being Moved to Ice Bath

Core Ice Bath

Moving the Coring Assembly to the Core Processing Container

Core Processing Container

Figure B2. Drill Ship

APPENDIX C. Geochemistry

Figure C1. Geochemistry Lab

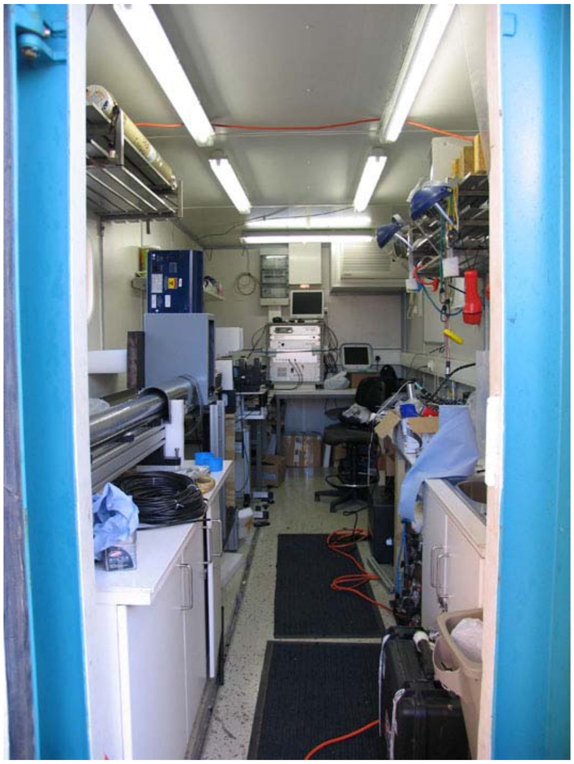


Figure C2. Preparing a Core for Testing

APPENDIX D. Drawings and Photos of Experimental Equipment

Figure D1. Portable X-Ray System for Geologic Core

- **Microfocal X-ray Source**

  45–130 kV, 0.5mA

- **Cylindrical Sample**

  1.5 m × 9.5 cm

- **Core rotated on vertical axis**
- **15 cm image intensifier**
- **X-ray filter for multi-energy scanning**
- **Attenuation compensator**
- **Cabinet safe**
- **Resolution 200μm**

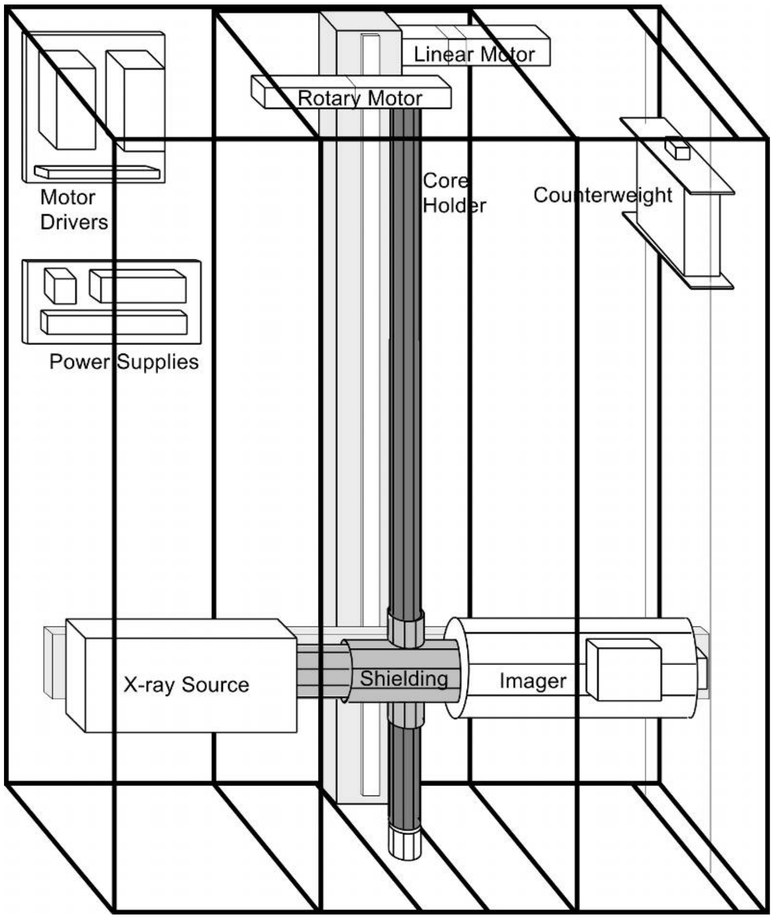


Figure D2. Pressure Coring Equipment

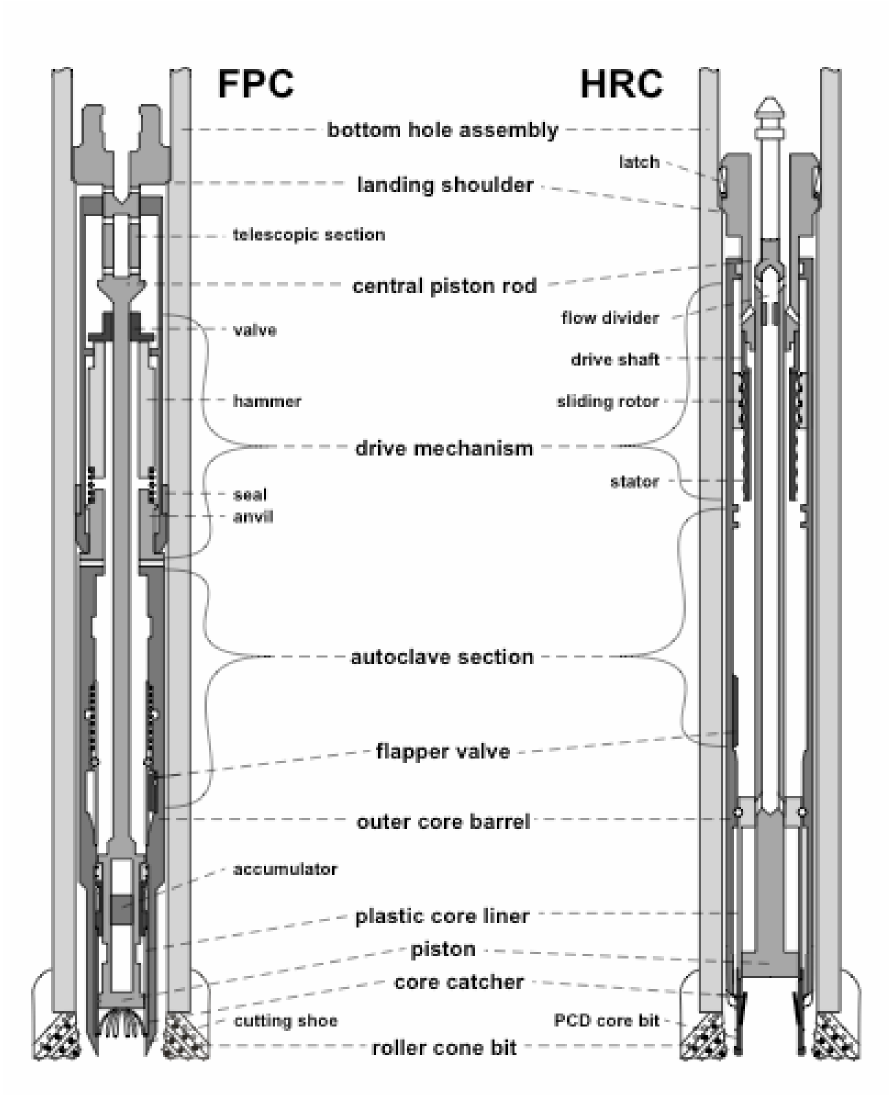
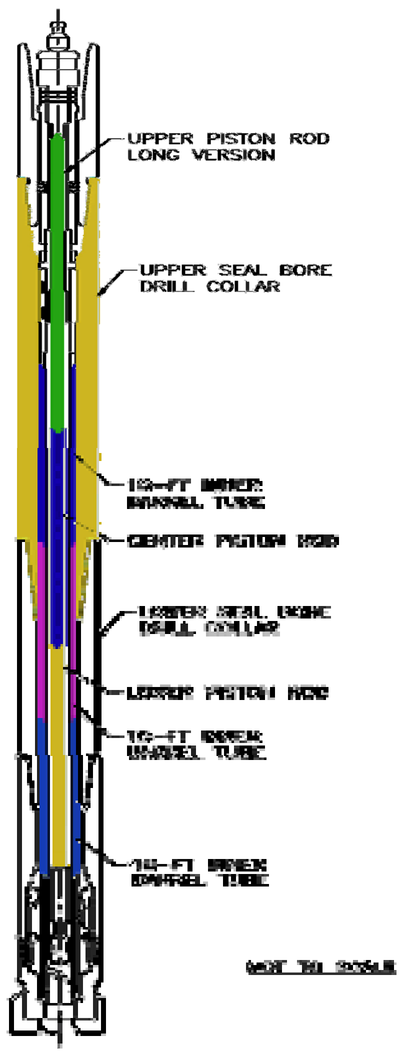


Figure D3. Conventional Coring Equipment

FHPC



FC

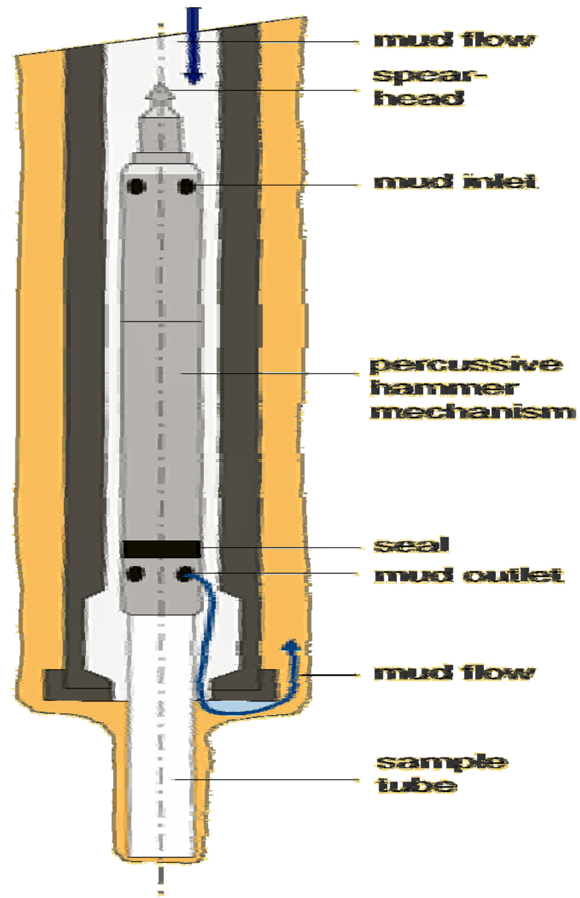


Figure D4. Core Transfer and Cutting Equipment

Pressure Core Cutting and Transfer

Pressure Core Transfer

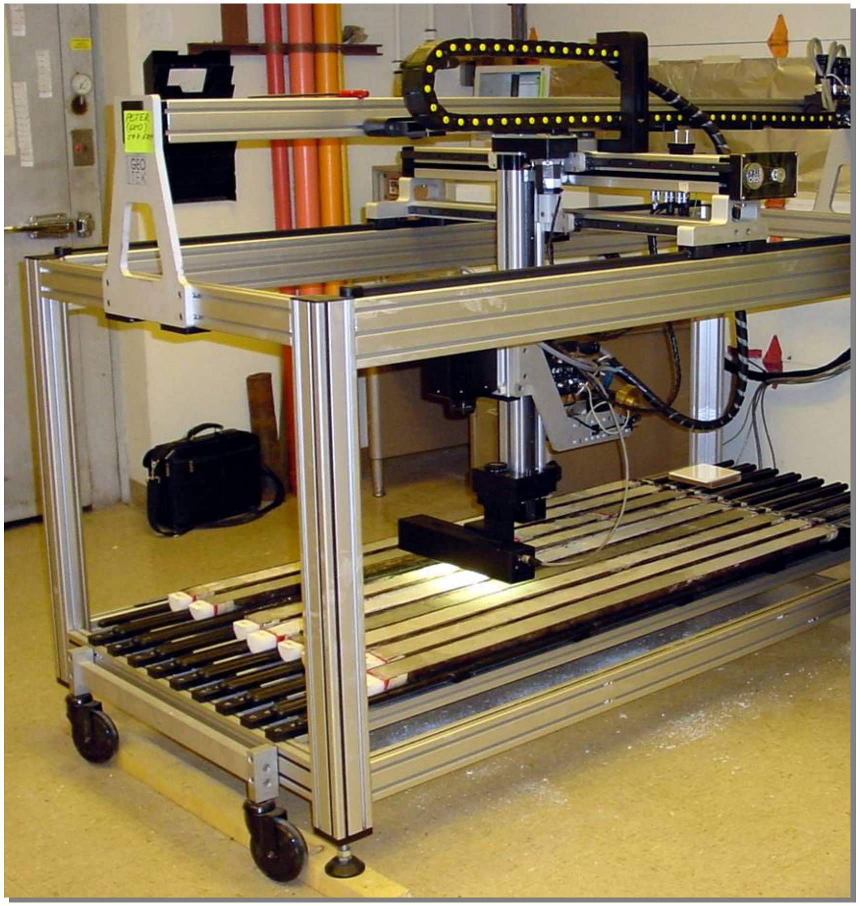
Figure D5. Multi Sensor Logger

Multi Sensor Core Logger Cold Room

Multi Sensor Core Logger

Figure D6. Gamma Ray and Core Photos

Shore Based Scanning and Photos of Cores



Sample of Data to be Archived from Post Cruise Experiments

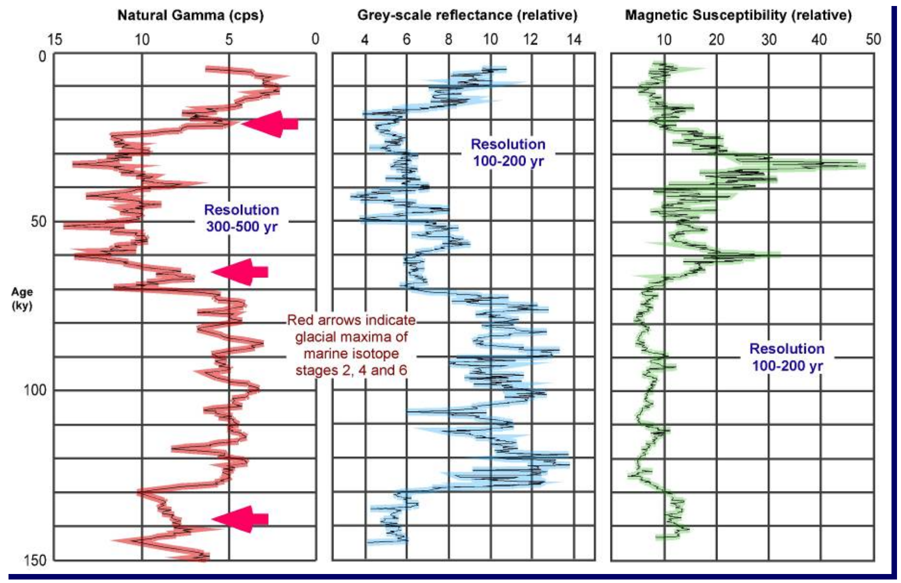


Figure D7. JIP Leg 1 – LWD tool string:

VDN

(density-neutron porosity)

ProVison

(NMR porosity)

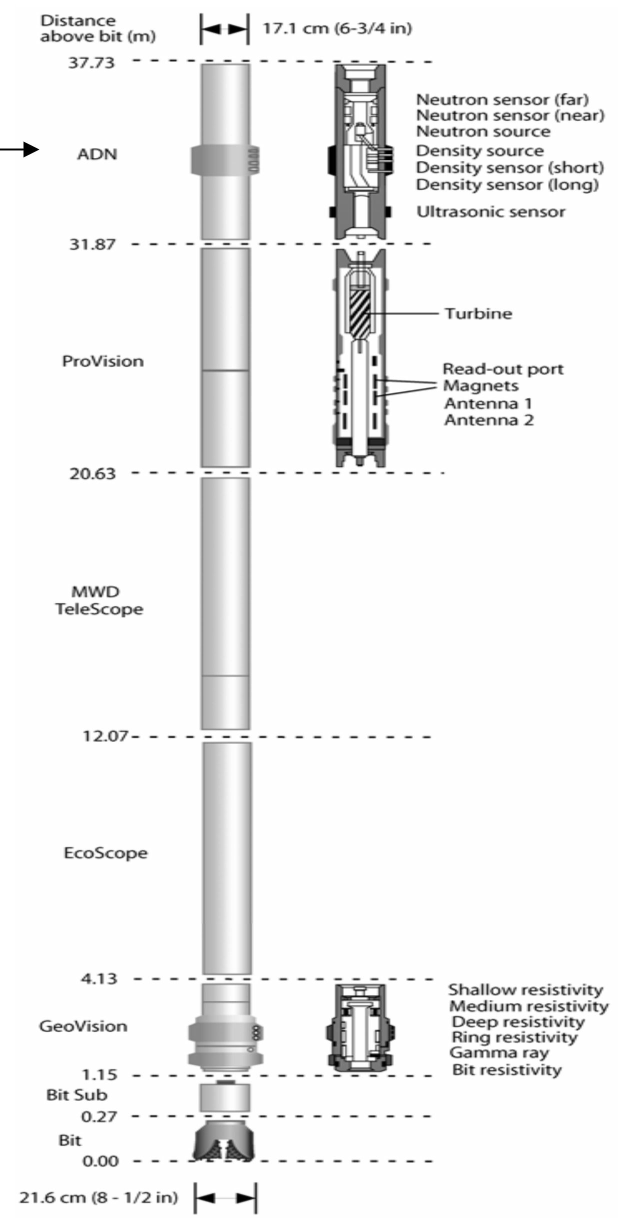
MWD

EcoScope

(resistivity, density-neutron porosity),

GeoVision

(conductivity)



sity)

Figure D8. JIP Leg 1 – Wireline tool string:

Gamma Ray

Dipole Shear Sonic Imager

(Vp and Vs)

GPIT

(inclinometer)

FormationMicro Scanner

(resistivity image)

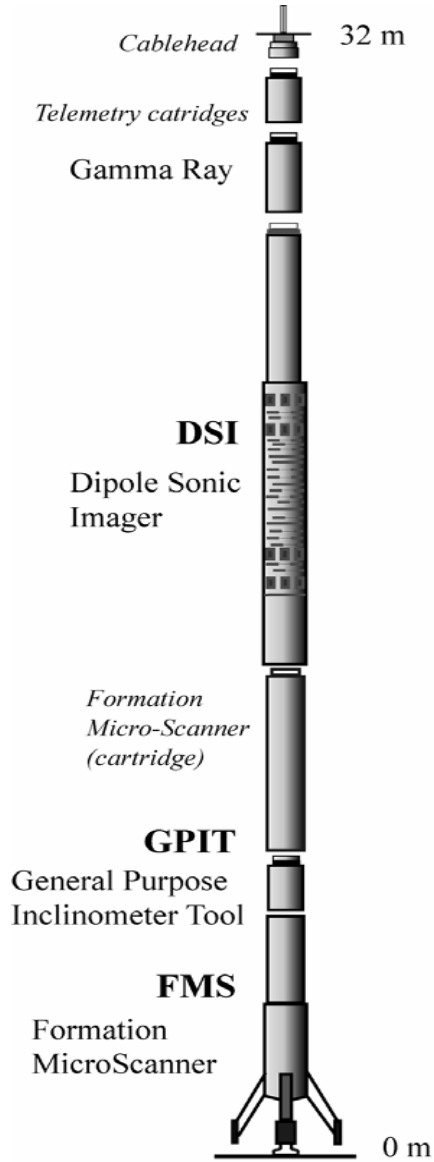


Figure D9. JIP Leg 1 – Vertical Seismic Profile (VSP) tool string:

Gamma Ray

Zero Offset Survey w/ four shuttles (2.06 m spacing)

Hole: KC 151-3   104 stations

124-334 mbsf

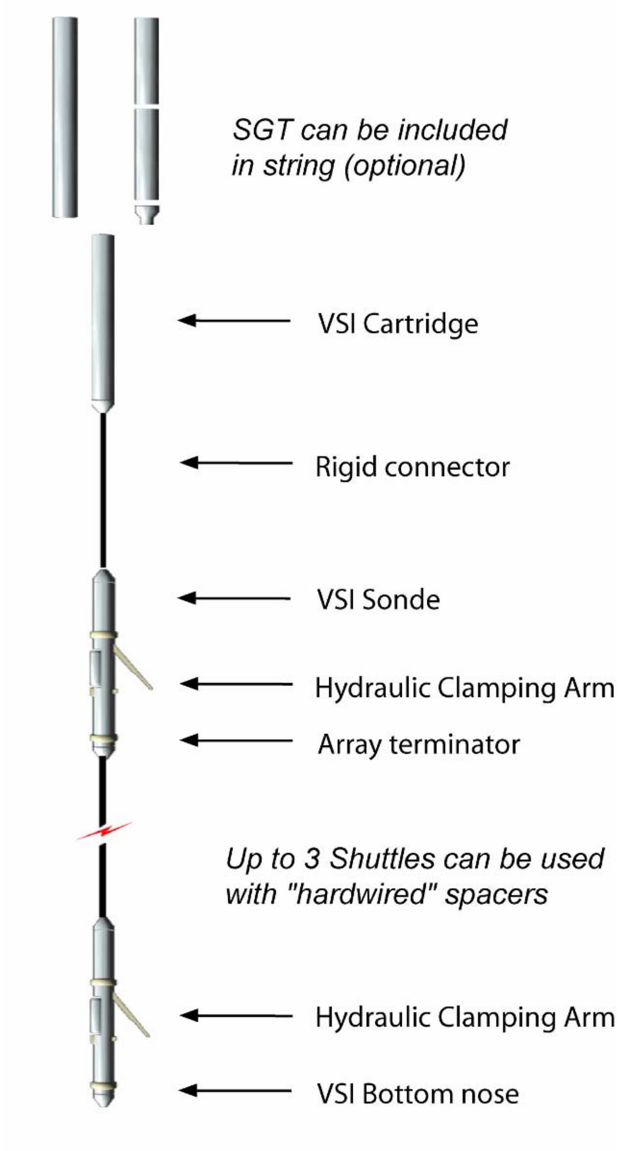


Figure D10. Gas Analyses Onboard

- **Gas chromatograph**
- **N2, O2, H2S, CO2, C1-C4**
- **Hydrocarbon composition in relation to pore water chloride and SO4 concentration**
- **Determines gas hydrate phase boundaries**
- **Real-time drilling hazards**

Figure D11. Lab Containers on the Drill Ship

Figure D12. Photo of Pressurized Measurement Vessel