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

Report Type: Semi-Annual
No: 41330R11

Starting	**April 2006**
Ending	**September 2006**

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November 2006

DOE Award Number: DE-FC26-01NT41330

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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 2006 – September 2006, the JIP concentrated on:

- Conducting experiments on the cores collected;
- Holding a workshop to presents to results of the 2005 drilling;
- Selecting sites for Phase III drilling seismic analysis.
- Contracting with Scripps, Georgia Tech, and WesternGeco.

More information can be found on the JIP website.

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

TABLE OF CONTENTS

LIST of TABLES & FIGURES

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 March 2006 the members of the JIP were Chevron, Schlumberger, ConocoPhillips, 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 2006.

1.6 Purpose of This Report

The purpose of this report is to document the activities of the JIP during April 2006 – September 2006. 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, https://cpln-www1.chevrontexaco.com/cvx/gasjip.nsf, are used to point the reader to more detailed information concerning various aspects of the project. The discussion of the work performed during April 2006 – September 2006 is organized by task and subtask for easy reference to the technical proposal and the DOE contract documents.

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.

The title of the project is

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

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. A revised Phase II work plan and budget was prepared and submitted to the DOE in March 2006. During the period from April 2006 to September 2006 several meetings and workshops were conducted. The project manager also reported on progress to the DOE through e-mail and conference calls.

2.2 GOM Hydrate JIP/DOE Drilling Data & Hydrate Tool & Protocol Development

The workshop was held in April 2006 and was well attended. All of the available data from the cruise was presented and several breakout sessions were held to provide input on additional work required.

2.3 Site Selection

A site selection meeting was held on 7 September 2006 in Houston. The attendees agreed that AC 818 and AC 857 were the best locations to consider for drilling in 2007 and 2008.

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. The final Phase II revision was submitted to the DOE in March of 2006 along with a revised budget to complete Phase II and prepare a proposal for Phase III.

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 progress on the project and changes to the research plan. The DOE project manager also attended the April 2006 Workshop and the August 2006 Site Selection Meeting.

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. Georgia Tech's complete report was presented in previous semiannual reports.

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 of the staff responsible for the well bore model collected data necessary to determine the performance of the model. The final report on the well bore stability model is being prepared and should be received in October of 2006.

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 the mound. A complete operation and drilling summary was presented in previous semiannual reports.

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.

Leg 1 core and log data was presented in a workshop in April 2006 and in previous semiannual reports. Geotechnical data was received from Rice University and will be reported on later.

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.

The workshop was held in Houston on 13 and 14 April 2006. The workshop agenda is presented below. Presentations from the workshop and breakout session discussions will be reported in a DOE Topical Report.

Agenda

GOM Hydrate JIP/DOE Drilling Data & Hydrate Tool & Protocol Development

13&14 April 2006
Hilton Houston Westchase
9999 Westheimer
Houston, Texas

Attendees (Presenting)

Brandon Dugan	George Claypool	Miriam Kastner	Emrys Jones
Barry Freifeld	Tom Lorenson	Ben Bloys	Fred Snyder
Sheila Noeth	Tim Collett	Carolyn Ruppel	

Attendees (Breakout Group Leaders)

Tim Collett	Testing protocols and equipment for evaluating hydrates
Deborah Hutchinson	Recommend geologic setting for additional drilling
Randy Utech	Seismic protocols for predicting hydrate occurrence
Ben Bloys	Recommend development of coring tools

Meeting Goals

1. Provide a summary of the data collected in the 2005 GOM Drilling

2. Discuss and recommend geologic setting for additional drilling

3. Discuss and recommend development of coring tools to be used for evaluating hydrates in sediments

4. Discuss and recommend improvements for seismic protocols for predicting hydrate occurrence

5. Discuss and recommend improvements for testing protocols and equipment for evaluating hydrates in the field and lab

13 April 2006

Time	Item	Responsible Person
8:00 AM	Continental Breakfast	All
9:00 AM	Introductions	All
9:05 AM	Agenda Review	Emrys Jones
9:10 AM	Safety Minute	Emrys Jones
9:15 AM	Meeting and JIP Goals	Emrys Jones
9:30 AM	Cruise Operations	Ben Bloys
10:00 AM	LWD and Wireline Logging Results	Timothy Collett
10:30 AM	Break	All
10:45 AM	Core-lab studies and pressure core measurements	Carolyn Ruppel
11:15 AM	Physical Properties	Brandon Dugan
11:45 AM	Pore water chemistry	Miriam Kastner
12:15 PM	Lunch	All
1:15 PM	Gas geochemistry	George Claypool
1:45 PM	Well Bore Modeling	Sheila Noeth
2:15 PM	Cruise Report	George Claypool
2:45 PM	Break	All
3:00 PM	Precruise Seismic Predictions	Fred Snyder
3:30 PM	Breakout Groups	All
5:00 PM	Adjourn for the day	Emrys Jones

14 April 2006

Time (min)	Item	Responsible Person
8:00 AM	Continental Breakfast	All
9:00 AM	Breakout Groups	All
10:30 AM	Break	All
10:35 AM	Review Agenda	Emrys Jones
10:40 AM	Safety	Emrys Jones
10:45 AM	Breakout Groups Report	Emrys Jones
11:45 AM	Adjourn and lunch	Emrys Jones
12:45 PM	Meeting Adjourned	Emrys Jones

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).

After reviewing the performance of pressure coring devices and factoring in the need to sample sands containing hydrates, it was decided to develop a pressure coring tool based on the design used by Japan in the Artic and offshore Japan. Negotiations are in progress with the company that owns the rights to produce the Japanese design to determine if the operating pressure can be increased and transfer capability can be added.

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.

A site selection meeting was held on 7 September 2006 in Houston. The meeting followed the April 2006 breakout group's recommendations and reviewed the sites that were pulled from the MMS Data Base. The MMS Data Base was reviewed by MMS, USGS, and DOE personnel and 6 locations were reviewed in the September Meeting. The complete list of locations as well as meeting notes and agenda are presented in Appendix A. The attendees agreed that AC 818 and AC 857 were the best locations to consider for drilling in 2007 and 2008. An analysis of the logs from the #1 well in AC 818 indicates that there is about a 20-meter thick sand that should contain hydrates at

high concentrations. The location of AC 818 is shown in Figure 3.1 and the log from AC 818 is presented in Appendix B.

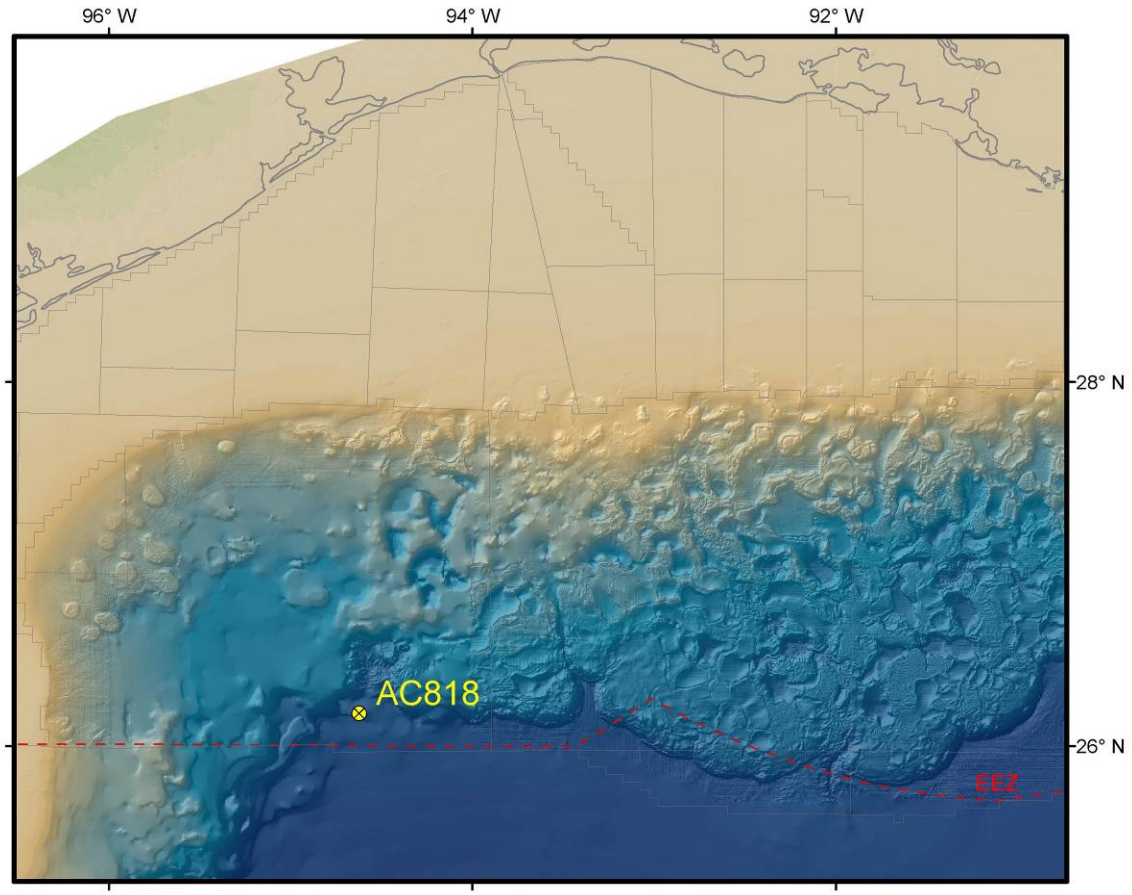

FIGURE 3.1. Location of AC 818

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 were presented in previous semi-annual reports.

6.0 Conclusions

The GOM Hydrate JIP/DOE Drilling Data & Hydrate Tool & Protocol Development Workshop was well attended and the breakout sessions provided valuable input for planning the next phase of work.

After reviewing the MMS sand/hydrate data base and considering other possible locations, AC 818 and AC 857 were selected for further seismic analysis.

7.0 References

No external references were used for this report.

8.0 Appendix

APPENDIX A. Site Selection Meeting Notes and Agenda

SITE SELECTION MEETING

SEPTEMBER 7, 2006

Houston, Texas

WesternGeco Office

Meeting Goal -- to review possible drilling locations identified in the MMS data base and provided by others and select candidate locations for seismic analysis and drilling.

Action Items

1. Nader Dutta will send out copies of presentation to meeting attendees.
2. William Shedd will send out copies of the well log discussed.
3. Mike Smith will send out recommendations to the attendees and JIP EB.
4. Emrys Jones will distribute meeting notes.

Results and Recommendations

Most of the locations identified were discounted because the anomaly identified in the well logs was below the base of the hydrate stability zone (see Locations Considered Table).

AC 818 and AC 857 will have additional seismic analysis performed to determine if target drilling locations can be identified that meet the scientific objectives of the project.

Agenda

Item	Topic & Desired Outcome	Person	Approx. Time
1	Safety Moment, Review Agenda	Mike Smith	9:00 AM
2	Introductions	All	9:05
3	JIP and Meeting Goals	Mike Smith, Emrys Jones, Ray Boswell	9:10
4	MMS Hydrate National Assessment	Bill Shedd	9:20
5	Industry wells with definite or possible hydrate sands	Bill Shedd, Mike Smith, and others	9:50
6	Break		10:15
7	Discussion of prospective GOM hydrate areas	All	10:30
8	Lunch	All	11:30
9	Discuss and list all recommended hydrate locations	All	12:00
10	Develop short list of drilling sites	All	1:30
11	Break		2:00
12	Discuss and finalized short list	All	2:15
13	Review results, wrap-up and adjourn	Mike Smith, Emrys Jones	3:00

Geologic Setting and Selection Criteria for Additional Drilling

1. Sand-rich lithology within HSZ.
2. Place where drilling has proven hydrate and reasonable thickness of sand and/or subsurface evidence for hydrate-bearing mapped sand unit(s).
3. Evidence for active fluid conduits and Flux and/or excess charge (possible discrete gas beneath HSZ?).
4. Geologic variability that “fits” a petroleum system framework.

The above criteria were developed in one of the breakout sessions in April of 2006 Workshop. It was used to reduce the possible hydrate locations in the GOM based the MMS study of their seismic and well log data base.

LOCATIONS CONSIDERED

Block and Well Number	Water Depth (Ft)	Resistance (Ohms)	Depth of anomaly (Ft)	Maximum Estimated HSZ (FBML)	Q Seismic data	Lat	Lon	Top of Anomaly to BHSZ (Ft)
AC 24 G10379 #1	4851	1.5 to 2	7010 – 7600	1290	Yes	26.95	-94.76	-869
AC 818 G20863 #1	9004	40	10530- 10586	2049	No	26.17	-94.62	523
AC 857 G17565 #1	7995	2	9415-9470	1770	No	26.09	94.90	350
AC 857 G17565 #2	8013		9395-9590		No	26.09	-94.89	
AC 857 G17565 #3	8717		9810-10190		No	26.12	-94.86	
AT 92 G21829 #1	3414	2	4518- 4608	900	No	27.84	-89.77	-204
125 EB 597 G22288 #1	3352	5- 7	4785-4828	720	No	27.39	-94.70	-713
GB 460 G15900 #1	2501	10	4040-4110	500	No	27.51	-92.97	-1039
MC 118	2900				Yes			

Note if the last column is negative, then the anomaly is below the HSZ and hydrates are not the cause of the anomaly.

Attendees

	ATTENDEE	E-Mail	Telephone	Affiliation
1.	Siva Subramanian	sisu@chevron.com	832-854-4825	Chevron
2.	Bal Dhami	Baljit.dhami@total.com	713 647-3504	Total
3.	William Shedd	William.shedd@mms.gov	504 736-2497	MMS
4.	Deborah Hutchinson	dhutchinson@usgs.gov	508 457-2263	USGS
5.	Brandon Dugan	dugan@rice.edu	713 348-5088	Rice University
6.	Nader Dutta	NDUTTA@slb.com	832 274-1781	Schlumberger
7.	Emrys Jones	ejones@chevron.com	858 534-4212	Chevron
8.	Mike Smith	Michael.smith@mms.gov	504 736-2500	MMS
9.	Fred Snyder	fsnyder@slb.com	713 689-6884	Schlumberger
10.	Pat Hooyman	hooyman@slb.com	713 825-1785	Schlumberger
11.	Karen Glaser	Glaser2@slb.com	713 689-6960	Schlumberger
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28	Randal Utech	rutech@slb.com		Schlumberger

APPENDIX B. AC 818 Log

Potential Hydrate by Log Analysis