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

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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 – September 2002, the JIP concentrated on:

- Reviewing the tasks and subtasks on the basis of the information generated during the three workshops held in March and May 2002;
- Writing Requests for Proposals (RFPs) and Cost, Time and Resource (CTRs) estimates to accomplish the tasks and subtasks;
- Reviewing proposals sent in by prospective contractors;
- Selecting four contractors;
- Selecting six sites for detailed review; and
- Talking to drill ship owners and operators about potential work with the JIP.

More information can be found on the JIP website.

http://qpext.chevrontexaco.com/QuickPlace/wwuexpl_gashydrates/Main.nsf?OpenDatabase.

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1.0 Introduction

In 2000, Chevron Petroleum Technology Company (now ChevronTexaco) began a project to learn how to characterize the natural gas hydrate deposits in the deepwater portion of the Gulf of Mexico. ChevronTexaco 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 (now ChevronTexaco) 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".

1.1 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.

1.2 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, ChevronTexaco 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.

1.3 Research Participants

In 2001, Chevron (now ChevronTexaco) 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 2002, the members of the JIP were ChevronTexaco, Schlumberger, ConocoPhillips, and Halliburton, the Minerals Management Service (MMS), TotalFinaElf, and Japan National Oil Corporation. (Note: Reliance Industries Limited joined the JIP as of 2 January 2003.)

1.4 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 ChevronTexaco in place. A Semi-Annual Report has been written that covers the activity of the JIP through March 2002.

1.5 Purpose of This Report

The purpose of this report is to document the activities of the JIP during April – September 2002. 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 – September 2002 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 – September 2002 can be found on the JIP website. The link to the JIP website is as follows:

http://qpext.chevrontexaco.com/QuickPlace/wwuexpl_gashydrates/Main.nsf?OpenDatabase

2.0 Executive Summary

Chevron (now ChevronTexaco) 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 (now ChevronTexaco) 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, ChevronTexaco 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.

The original plan called for drilling three data collection wells using conventional deepwater drill ships and gas exploration protocol requirements. However, due to the success of the Ocean Drilling Project (ODP) in conducting scientific studies in gas hydrate areas, it is likely the JIP's approach to the data collection wells will mirror the ODP approach. Thus, it should be possible to drill considerably more than three data collection wells during Phase II within the budget limitations.

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

http://qpext.chevrontexaco.com/QuickPlace/wwuexpl_gashydrates/Main.nsf?OpenDatabase.

2.1 The Data Collection Workshop

The Data Collection Workshop was held in March 2002 to determine what data are available concerning natural gas hydrate deposits in the deep water Gulf of Mexico. The results from the three breakout groups can be found in the DOE Topical Report entitled

"Results from the (1) Data Collection Workshop, (2) Modeling Workshop and (3) Drilling and Coring Methods Workshop as part of the Joint Industry Participation (JIP) Project to Characterize Natural Gas Hydrates in the Deep Water Gulf of Mexico"

2.2 Drilling, Coring and Core Analysis Workshop

This workshop focused on the current state of the art with respect to planning for taking cores, safety issues, core sampling and preservation and core analysis. Detailed results from this workshop can be found both on the JIP website and in the DOE Workshop report cited above.

The objective of this workshop was to determine what is currently known regarding coring in hydrates and what major gaps in technology need to be filled. The three breakout sessions that will be conducted as part of this workshop are as follows:

- Session D1 – Drilling and Coring Well Plan and Safety Issues
- Session D2 – Core Sampling and Core Preservation
- Session D3 – Core Analysis

A **common theme** emerged during various discussions during this workshop. It was clear that there is a significant opportunity for the JIP to improve the state of knowledge of naturally occurring gas hydrates, by gathering in situ seafloor and/or wellbore data, via downhole instrumentation, over time. There is an almost total lack of in situ data taken over an extended period of time. The use of instrumentation on the seafloor and/or in wellbores could provide valuable insight into the stability of hydrates over time, and a better understanding of the process of disassociation.

2.3 Modeling, Measurements and Sensor Workshop

The workshop on Modeling, Measurements and Sensors focused on the current state of the art with respect to the stability of hydrate sediments, data required to improve modeling, the impact of local seafloor instabilities and the use and role of seismic and reservoir modeling to improve our understanding of hydrates.

Prior to starting the breakout sessions, a series of overview presentations were made.

- **“**Predictive Numerical and Effective Media Models of Gas Hydrate-Bearing Sediments” by Carolyn Ruppel, Georgia Tech
- “Kinetic Models of Hydrocarbon Gas Generation and Venting” by Larry Cathles, Cornell University
- “Sensors and Measurements” by Bob Kleinberg, Schlumberger

These three presentations can be found on the JIP website. Details concerning the Modeling, Measurements and Sensors Workshop can be found in the DOE Workshop report cited above.

2.4 Tasks and Subtasks

The following tasks and subtasks will be accomplished by the JIP during Phase I and Phase II of this research project. This Semi-Annual report uses the tasks and subtasks as a way of reporting the progress during April – September 2002 on Phase I of the project. **Table 2.1** presents these tasks and subtasks and their status (a check mark indicates that the task or subtask is complete).

Table 2.1 – Task and Subtask List

PHASE I: Data Collection, Analyses and Protocol Development
Task 1.0 -- Research Management Plan (Completed)
Task 2.0 -- Project Management and Oversight
Task 3.0 -- Data Collection and Organization ✓ Subtask 3.1 -- Data Committee ✓ Subtask 3.2 -- Workshop Attendance/Participation ✓ Subtask 3.3 -- Conduct Data Collection and Case Histories Workshop ✓ Subtask 3.4 -- Identify Data Platform ✓ Subtask 3.5 -- Data Protocol Subtask 3.6 -- Gulf of Mexico Natural Gas Hydrate Database
Task 4.0 -- Development of New Gas Hydrate Sensors ✓ Subtask 4.1 -- MWD Sensors for Gas Hydrates ✓ Subtask 4.2 -- Gas Hydrate Disassociation Sensor ✓ Subtask 4.3 -- Gas Hydrate Formation Sensor Subtask 4.4 -- Tech Transfer/Sensor Specifications
Task 5.0 -- Develop Well Bore Stability Model Subtask 5.1 -- Well Bore Stability Model Evaluation Subtask 5.2 -- Prototype Well Bore Stability Model Subtask 5.3 -- Well Bore Stability Model Evaluation/Tests Subtask 5.4 -- Well Bore Stability Model Validation
Task 6.0 -- Seismic Modeling and Analysis ✓ Subtask 6.1 -- Identify and Obtain Existing 2D and 3D Seismic Data Subtask 6.2 -- Theoretical Seismic Modeling Subtask 6.3 -- Protocol Development for Seismic Data ✓ Subtask 6.4 -- Specify Seismic Data Laboratory Tests Subtask 6.5 -- Seismic/Petrophysical Laboratory Tests
Task 7.0 -- Kinetics and Thermodynamics Analyses ✓ Subtask 7.1 -- Literature Analysis of Hydrate Kinetic/Thermodynamic Properties ✓ Subtask 7.2 -- Gas Hydrate Kinetic/Thermodynamic Data Analysis ✓ Subtask 7.3 -- Laboratory Test Specifications - Kinetic/Thermodynamic Data ✓ Subtask 7.4 -- Laboratory Test Specifications - Chemical/Physical Properties Subtask 7.5 -- Laboratory Testing - Kinetic/Thermodynamic Data Subtask 7.6 -- Laboratory Testing - Chemical/Physical Properties
✓ * Task or Sub-Task Completed

Task 8.0 -- Determine Data Requirements for GeoModels
✓ Subtask 8.1 -- Geoscience/Reservoir Modeling Committee ✓ Subtask 8.2 -- Geoscience/Reservoir Modeling Workshop Planning ✓ Subtask 8.3 -- Geoscience/Reservoir Modeling Workshop Subtask 8.4 -- Geoscience/Reservoir Modeling White Paper Subtask 8.5-- Data Collection Requirements for Future Phases
Task 9.0 -- Develop Drilling and Coring Test Plans ✓ Subtask 9.1 -- Drilling/Coring Committee ✓ Subtask 9.2 -- Drilling/Coring Modeling Workshop Planning ✓ Subtask 9.3 -- Drilling/Coring Modeling Workshop Subtask 9.4 -- Current Drilling Practices in Hydrates Areas Subtask 9.5 -- Scenarios for Drilling and Coring Gas Hydrates in Deep Water Subtask 9.6 -- Cost/Risk Analysis Subtask 9.7 -- Drilling/Coring Guidelines and Protocols
Task 10.0 -- Core Handling and Core Tests Subtask 10.1 -- Core Sample Information Subtask 10.2 -- Core Sample Protocols
Task 11.0 -- Review Data and Select Locations of 3 Field Test Sites ✓ Subtask 11.1 -- Field Test Sites - Short List Subtask 11.2 -- Comprehensive Database Evaluation Subtask 11.3 -- Additional Data Analysis Subtask 11.4 -- Field Test Sites Selection - 3 Sites Subtask 11.5 -- Prioritize Field Test Sites - 3 Sites
Task 12.0 -- Conference – Field Testing
PHASE II: Initial Field Tests and Analyses
Tentative tasks are presented for the Phase II activities. The tasks are provided to describe the generally anticipated work scope. Work will not proceed into Phase II until a continuation application (technical and cost) is submitted and approved by DOE/NETL.
Task 1.0 -- Research Management Plan
Task 2.0 -- Project Management and Oversight
Task 3.0 -- Validation of New Gas Hydrate Sensors
Task 4.0 -- Validation of the Well Bore Stability Model
Task 5.0 -- Core and Well Log Data Collection - Area A
Task 6.0 -- Data Analysis - Area A
Task 7.0 -- Update Models, Plans and Protocols
Task 8.0 -- Integrate New and Old Seismic Data in Test Areas Task 9.0 -- Conference - Information Transfer ✓ * Task or Sub-Task Completed

3.0 Technical Teams

This research project is managed by ChevronTexaco, whose Program Manager is Dr. Emrys Jones. Dr. Jones is assisted by an Executive Board. The Executive Board has the power to control the direction of the research and suggest contractors and subcontractors for various portions of this research effort.

Reporting to the Executive Board are four technical teams. Each of these teams has a team leader and participants from the other JIP member companies. Each person on the technical team is paid for their participation by the member companies as part of the cost sharing for this project. Time and expenses required in excess of the agreed contributions for each company may be paid for by the project. These funds will come from the portion of funds allocated for each task of the project. Ten of the tasks associated with Phase I of this project will be managed by the various technical teams.

The JIP has formed the following four technical teams.

- The Seafloor Stability Team is responsible for conducting Tasks 4, 8, and 11.
- The Drilling and Coring Team is responsible for Tasks 5, 9, and 10.
- The Hydrates Characterization Team is responsible for Tasks 3, 6, and 7.
- A fourth team, called the Technology Transfer Team, is in charge of writing the technical reports and papers to describe the research, and for planning Task 12.

After the three workshops held during March and May 2002, the technical teams prepared Cost, Time and Resource (CTRs) estimates for all of the tasks and subtasks listed above. The JIP member companies then worked with the Executive Board to determine who could and should do the work required by the JIP. Requests for Proposals (RFPs) were then prepared and bids were submitted for various tasks and subtasks. Some of the work was awarded to JIP member companies after appropriate bids were received and thoroughly evaluated. Much of the work was or will be put out for bid by placing RFPs on the JIP website, and sending out notices of the RFPs to interested parties, many of whom participated in one or all of the JIP workshops. After receiving all of the proposals, each technical team thoroughly evaluates the proposals and ranks them. The technical teams then recommend to the Executive Board the name of the organization(s) who should be awarded contracts.

Table 3.1 lists the RFPs and the contracts awarded through September 2002 by the JIP.

Table 3.1 – RFPs and Contracts Awarded During 2002 by JIP

Contract or RFP	Contractor
Technology Transfer	Schlumberger
Gas Hydrate Seismic Modeling and Analysis	WesternGeco
Wellbore Stability Modeling	Schlumberger
Effect of Thermal History on the Properties of Hydrate Core Samples	Georgia Tech
Drilling and Coring Well Plan	TBD
Core Handling and Testing	TBD

3.1 Executive Board

The Executive Board assists the ChevronTexaco Program Manager when it comes to determining which tasks are accomplished, and how the contracts and subcontracts are handled within this research project. The Executive Board consists of one person from every company participating in this joint industry project. As of September 2002, the Executive Board consisted of the following individuals.

- Craig Lewis — ChevronTexaco, Chairman
- Steve Holditch — Schlumberger
- Lewis Norman — Halliburton
- Ravi Aurora — ConocoPhillips
- Jesse Hunt — Minerals Management Service
- Pierre Montaud — TotalFinaElf

- Tesuo Yonezawa			Japan National Oil Corporation

The Executive Board met five times from April – September 2002. **Table 3.2** shows when the Board met and the essence of the topics at the meetings.

Table 3.2 – Record of Executive Board Meetings

Number	Date	Topics
1	4/25/02	• Discuss plans for the next two workshops • Update on budget • Update on CTRs and procurement guidelines • Discuss guidelines for JIP website
2	5/10/02	• Review results from May workshops • Technical team updates • DOE and JIP accounting updates • Discuss new JIP members • Discuss procurement guidelines
3	6/5/02	• Technical team updates • CTR updates • Accounting update • Discuss new JIP members
4	6/13/02	• Met with Technical Team Chairmen to review CTRs and compare them to the original cost estimate
5	8/28/02	• Discuss new JIP member • Accounting update • Discuss in-kind contributions • Discuss RFPs and issuing of contracts • Discuss status of Joides-Resolution

3.2 Hydrates Characterization Team

As of September 2002, the Hydrates Characterization Team consisted of the following individuals.

- Jesse Hunt MMS
- Siva Subramanian ChevronTexaco
- Bill Parrish, Team Leader Phillips
- Steve Primeau Conoco
- P. Montaud TotalFina Elf
- Rick Coffin NRL
- Peter Eick Conoco
- Nader Dutta WesternGeco
- Mike Curtis Halliburton
- Bill Hottman Halliburton
- Tim Collett USGS
- Lecia Muller WesternGeco

The Gas Hydrates Characterization Team Charter can be found on the JIP website and in the JIP Semi–Annual Report for October 2001 – March 2002.

The following five meetings were held by the Gas Hydrates Characterization Team between April – September 2002.

Table 3.3 – Record of Gas Hydrates Characterization Team Meetings

Number	Date	Topics
1	4/16/02	• Review the results from the data collection workshop • Establish next phase in data collection • Start building CTRs for the project
2	6/12/02	• Update and review on CTRs and procurement guidelines • Start planning next workshop and our input
3	5/10/02	• Review results from next two workshops • Technical team updates • DOE and JIP accounting updates • Discuss new JIP members • Discuss procurement guidelines
4	6/13/02	• Update the EB on CTRs and workshop progress.

5	7/24/02	• Update the CTRs • Establish team goals for CTR's and oversight of contracts

3.3 Drilling and Coring Team

As of September 2002, the Drilling and Coring Team consisted of the following individuals.

- Jim Schumacher ChevronTexaco
- Jacques Bourque Schlumberger
- Tetsuo Yonezawa JNOC
- Gary Weaver Halliburton
- Ben Bloys ChevronTexaco
- G. Leon Holloway ConocoPhillips
- Terry Cook Phillips
- Larry Williamson NRL MMS
- Carole Fleming ChevronTexaco
- Brian Jonasson ODP
- Terry Shawchuk Orion

The Drilling and Coring Team Charter can be found on the JIP website or in the JIP Semi-Annual Report for October 2001 – March 2002.

The following meetings were held by the Drilling and Coring Team during April – September 2002. Details of the meeting results can be found on the JIP website.

Table 3.4 – Record of Drilling and Coring Team Meetings

Number	Date	Topics
1	4/30/02	• Update to Executive Board
2	6/13/02	• Met with Technical Team Chairmen to review CTRs and compare them to the original cost estimate
3	4/24/02	• Learn to use Hydrate JIP web-site • Plan Drilling Workshop

		• Discuss how we will issue RFPs and guidelines for selecting contractors for specific projects
4	9/11/02	• Review information for Joides Resolution visit • Refine CTRs for coring/drilling plan and core analysis

3.4 Seafloor Stability Team

At the end of 2002, the Seafloor Stability Team consisted of the following individuals.

- Jen-Hwa Chen ChevronTexaco
- Jeff Mueller ConocoPhillips
- John Matson Halliburton
- Michael A. Smith MMS
- Bob Kleinberg Schlumberger
- Jorge Manrique Schlumberger

The Seafloor Stability Team Charter can be found on the JIP website and in the JIP Semi-Annual Report for October 2001 – March 2002.

The following meetings were held by the Seafloor Stability Team during April – September 2002. Details of the meetings can be found on the JIP website.

Table 3.5 – Record of Seafloor Stability Team Meetings

Number	Date	Topics
1	4/9/02	• Outstanding issues for May workshops • Prepare CTRs in Seafloor Team's responsibility • Potential tasks requiring external resources
2	4/30	• Closure for all outstanding issues for Modeling Workshop
3	5/9-10/02	• Host Modeling Workshop • Facilitate breakout sessions • Post workshop review
4	6/13	• Update progress of CTRs

4.0 Results and Discussion – Phase I – Tasks for Data Collection, Analyses and Protocol Development

4.1 Task 1.0 – Research Management Plan (Completed)

ChevronTexaco developed a work plan and supporting narrative that concisely addressed the overall project as set forth in the Technical Proposal and DOE Contract. The Research Management Plan ("The Plan") provides a concise summary of the technical objectives and the technical approach for each Task and, where appropriate, each Subtask. The Plan provides detailed schedules and planned expenditures for each Task using graphs and tables as needed. The Plan contains all major milestones and decision points. The Plan was submitted to DOE on January 31, 2002. **Table 4.1** presents the milestones and decision points that were part of the Plan.

Table 4.1 – Milestones for Phases I and II

	Year	Timing	Milestone
Phase I	2001	Q4	Technical Teams formed and staffed
	2002	Q1	Hold a data and case histories workshop
	2002	Q2	Construct data and case histories database
	2002	Q3	Meet with industry to discuss specifications on gas hydrates sensors
	2003	Q1	Develop prototype wellbore stability model
	2003	Q1	Publish laboratory test results on kinetic, physical, and chemical properties of cores saturated with gas hydrate.
	2002	Q2	Conduct geomodeling workshop
	2002	Q1	Conduct drilling and coring workshop
	2002	Q4	Develop protocols and plans for data collection wells
	2002	Q2	Develop protocols for core handling and testing
	2002	Q4	Select and prioritize sites for data collection wells
	2003	Q1	Hold 2-day conference to review Phase I results and solicit input and interest for data collection wells
	2003	Q1	Final report on Phase I

	Year	Timing	Milestone
Phase II	2003	Q2	Meet with service companies to review new sensor design
	2004	Q4	Produce and distribute protocols for new gas hydrate sensors
	2004	Q1	Publish and distribute wellbore stability model
	2004	Q1	Drill Well A1
	2004	Q1	Drill Well A2
	2004	Q1	Drill Well A3
	2004	Q4	Hold 2-day conference to present results from data collection wells
	2005	Q1	Final report on Phase II

4.2 Task 2.0 – Project Management and Oversight

Dr. Emrys Jones was appointed Project Manager by ChevronTexaco to manage the JIP and the DOE Contract. The work has been delegated to Technical Teams and to Contractors. Dr. Jones manages the day-to-day operation of the project and reports verbally and by written report on the progress of the project to the DOE, as required. The organization chart for this project is given in **Fig. 4.1**.

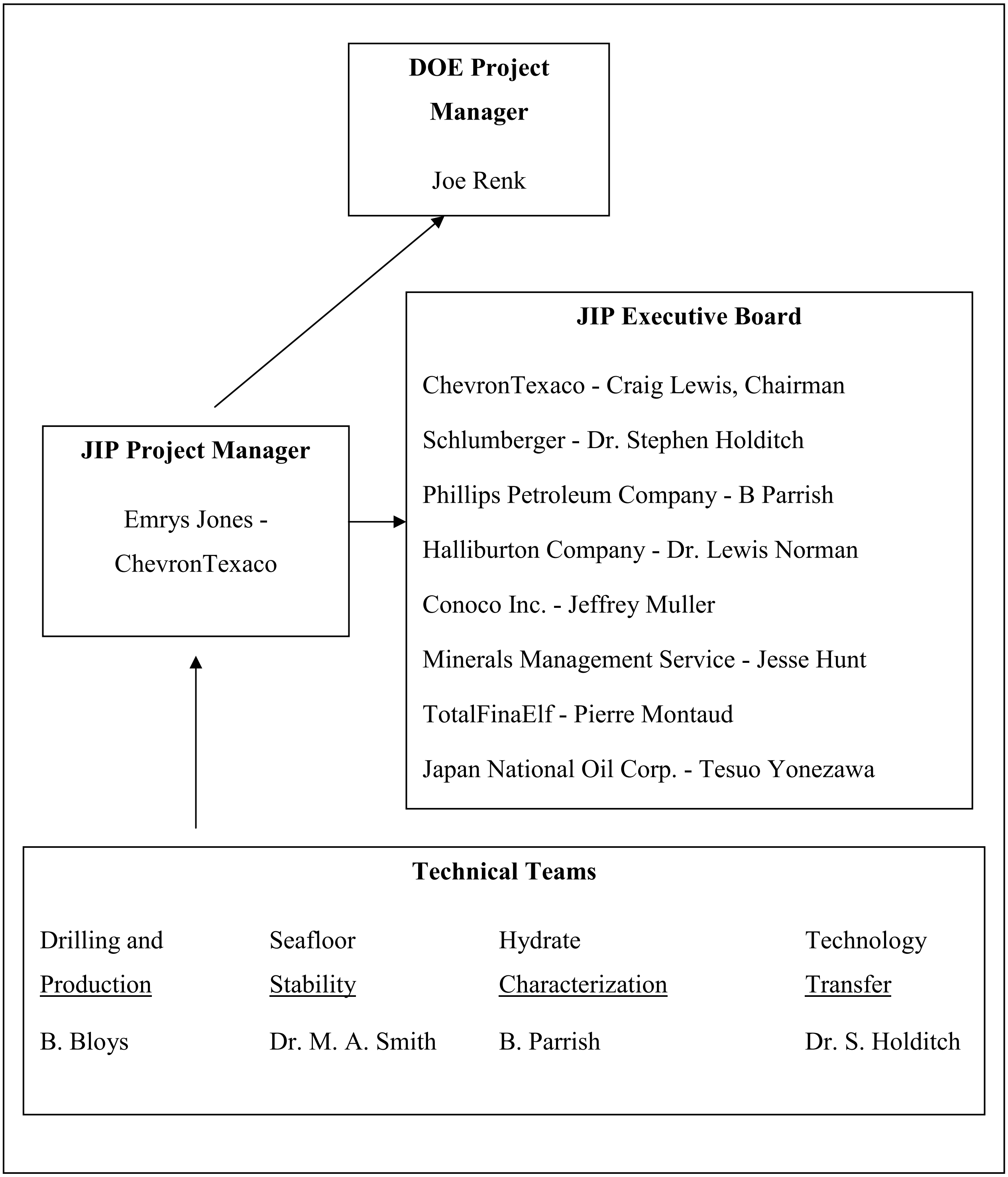

Fig. 4.1 – Organization Chart for "Characterizing Natural Gas Hydrates in the Deep Water Gulf of Mexico"

4.3 Task 3.0 – Data Collection and Organization

A committee was formed to plan a data and case histories workshop. The committee solicited interest from the oil and gas, scientific, and academic communities to participate in the data and case histories workshop. The committee organized and held a workshop to collect data and case histories on the successes, failures, and lessons learned from field operations where hydrates may have been encountered in drilling, production, or pipeline installation and operation. After the workshop, the JIP collected the information, and stored it on the JIP website for public access.

4.3.1 Subtask 3.1 – Data Committee (Completed)

During January 2002, the Gas Hydrates Characterization Team planned the workshop for compiling data and case histories concerning operations in the deep water Gulf of Mexico, as it relates to gas hydrates on or near the seafloor. The Team defined objectives for the workshop and prepared a very detailed agenda. The Team worked hard to solicit keynote speakers and presenters for the breakout sessions.

4.3.2 Subtask 3.2 – Workshop Attendance (Completed)

The Hydrates Characterization Team solicited interest from the oil and gas, scientific, and academic communities to participate in the data and case histories workshop. Using email lists from the DOE, and personal communication, the Team contacted oil and gas operators who have interest in deepwater prospects in all parts of the world, service companies, national research laboratories, private research institutes, certain consulting organizations, government organizations, and academic communities and solicited interest in participating in a data and case histories workshop.

4.3.3 Subtask 3.3 – Conduct Data Collection Workshop (Completed)

A workshop to collect data and case histories on the successes, failures, and lessons learned from field operations where hydrates may have been encountered in drilling, production, or pipeline installation and operation was held in Houston in March 2002. The main purpose of the workshop was to collect data and case history information. The JIP obtained information that documents where the gas hydrates are located (at least based on then current information), how many wells have been drilled through areas that could possibly contain gas hydrates, various drilling problems encountered that could possibly be attributed to gas hydrates, and other pertinent information in the deep water GOM.

The purpose of the data collection task was to obtain the information required (and available) to select the sites for collecting cores and well log data, and to actually plan and conduct the remaining tasks in this research project. The data collection task also highlighted for us what additional data are required (that currently do not exist) to properly conduct this research project.

A detailed DOE report was written to capture the information generated at the Data Collection Workshop.

4.3.4 Subtask 3.4 – Identify Data Platform (Completed)

The JIP, following the recommendations of the Project Manager and the Hydrates Characterization Team, decided to use the a third party program "QuickPlace" as the platform for collecting and disseminating the information obtained in the data and case histories workshop, as well as all other information generated by the JIP. The JIP website can be accessed using the following Web address.

http://qpext.chevrontexaco.com/QuickPlace/wwuexpl_gashydrates/Main.nsf?OpenDatabase.

4.3.5 Subtask 3.5 – Data Protocol (Completed)

The Hydrates Characterization Team, working with ChevronTexaco developed the protocols needed for collecting, storing, and disseminating data on natural gas hydrates in the Gulf of Mexico. Essentially, the QuickPlace website tools of ChevronTexaco have been used to store data using software such as Microsoft Word and Excel.

4.3.6 Subtask 3.6 – Build Gulf of Mexico Gas Hydrates Database

The database of information concerning natural gas hydrates in the deep water Gulf of Mexico has been constructed. JIP members have access to all of the information. In time, essentially all of the data will be available to anyone. The database is a central repository for all data that will be generated and/or obtained during the remainder of this research project. The database can be accessed using the following web address.

http://qpext.chevrontexaco.com/QuickPlace/wwuexpl_gashydrates/Main.nsf?OpenDatabase.

4.4 Task 4 – Development of New Gas Hydrates Sensors

The Seafloor Stability Team is in the process of determining the feasibility of developing MWD sensors for gas hydrates. The team is developing specifications for feasible sensors. The team plans to meet with service companies, national laboratories and other groups to discuss these specifications

4.4.1 Subtask 4.1 – MWD Sensors for Gas Hydrates (Completed)

The Seafloor Stability Team has looked into the feasibility of developing MWD sensors for gas hydrates. At the Modeling, Measurements and Sensor Workshop held in Houston in March 2002, a portion of the workshop dealt with sensors. Dr. Robert Kleinberg made a keynote presentation and a breakout session was devoted entirely to discussing existing sensors and the need for new sensors.

4.4.2 Subtask 4.2 – Gas Hydrate Disassociation Sensor (Completed)

Gas hydrates found in the formation near the seafloor may begin to disassociate into gas and water as the pressure and temperature change during drilling or producing conditions. The exact values of pressure and temperature when disassociation occurs are a complicated issue and depend on a number of parameters. The Seafloor Stability Team discussed what occurs when gas hydrates begin to disassociate and what can be measured, and has developed specifications for a sensor(s) that can help us determine when gas hydrates begin to disassociate.

4.4.3 Subtask 4.3 – Gas Hydrate Formation Sensor (Completed)

Gas hydrates will form as gas and water are mixed under certain pressure and temperature conditions. The formation of gas hydrates is a very complicated issue, one that depends on many parameters. However, as gas hydrates form, chemical and physical reactions occur that could possibly be detected by sensors. The Seafloor Stability Team discussed what occurs when gas hydrates form and what can be measured, and has developed specifications for a sensor(s) that can help us determine when gas hydrates form.

4.4.4 Subtask 4.4 – Sensor Specification and Technology Transfer

The Seafloor Stability Team is currently writing a White Paper that will address all the issues concerning existing sensors and required sensor development to measure the properties of gas hydrate deposits in situ. After the White Paper has been completed, the JIP will conduct a series of meetings with any service company and/or research organization that would like to receive the information. The plan would be for the companies or organizations to take the information in the White Paper and then develop the required sensors using their own research dollars. We do not plan to fund any sensor development during this research project.

4.5 Task 5 – Develop Wellbore Stability Model

The JIP issued a contract to Schlumberger to determine the feasibility of building a wellbore stability model for boreholes that penetrate natural gas hydrate zones. Assuming the task is feasible, Schlumberger will recommend an organization to build a prototype wellbore stability model. To provide information for the model developers, the JIP is designing laboratory tests for measuring the stability of boreholes with typical formation containing natural gas hydrates, and then laboratory tests will be conducted to help verify the wellbore stability model. Finally, the JIP plans to validate the prototype wellbore stability model with both laboratory and field test data.

4.5.1 Subtask 5.1 – Wellbore Stability Model Evaluation

Wellbore stability models are in common use in the oil and gas industry. These models are used routinely to design slanted, horizontal and multilateral wells. Wellbore models can also be used to determine if sand control measures are required and to assist engineers in designing stimulation treatments. The data for these wellbore stability models have been measured in both the laboratory using core samples and in the field using wire line conveyed tools. For conventional formations, wellbore stability models are very reliable.

However, we are not aware of the use of wellbore or seafloor stability models that have been developed and tested to investigate the stability of wellbores that penetrate formations containing gas hydrates. The JIP has awarded a contract to Schlumberger to find out what models have been developed, and if such models can be modified to handle the problem for a wellbore penetrating a formation containing gas hydrates. Schlumberger will define the specifications for a wellbore stability model that can be used in formations containing natural gas hydrates.

In order to scorecard existing wellbore stability models and address further hydrate modeling requirements, Schlumberger will send out a questionnaire to industry experts, government organizations and universities comprising the following set of questions:

- What type of wellbore stability model(s)/software do you use?
- Have these models been used in conjunction with drilling through gas hydrates?
- Are you aware of wellbore stability modeling software developed by others that may be applied to sediments containing gas hydrates?
- Could you document the abilities of wellbore stability models you are familiar with, developed either by you or others, through case studies and references?
- Are you aware of any laboratory tests, or log and core databases, on gas bearing sediments from the Gulf of Mexico or from other locations?
- Could you document through references any laboratory results you are aware of on the mechanical and other properties of gas hydrate bearing sediments?
- What requirements do you consider essential for a wellbore stability model to be applicable to gas hydrate bearing sediments in the Gulf of Mexico? You may
    - Discuss the nature of the geologic material,
    - Effects of gas hydrates on material properties,
    - Effect of drilling through gas hydrate bearing materials,
    - Characteristic failure mechanisms, numerical modeling algorithms, and/or
    - Any other issue you may consider important.

4.5.2 Subtask 5.2 – Prototype Wellbore Stability Model

Once the feasibility study is concluded, the JIP, through its contract with Schlumberger, will put out a request for proposal to determine the best organization for building a prototype wellbore stability model. We will specify the requirements of the prototype and try to leverage existing technology. A subcontract will be let to build the gas hydrates wellbore stability model.

4.5.3 Subtask 5.3 – Wellbore Stability Model Testing

It is highly unlikely that sufficient laboratory data are available that can be used to validate the prototype wellbore stability model. As such, Schlumberger is preparing specifications concerning the data the JIP will require from laboratory tests to verify the accuracy and calibrate the wellbore stability model. Once the specifications and data requirements have been decided, Schlumberger will write a request for proposal and entertain proposals from interested organizations that wish to conduct the required laboratory tests. A subcontract will then be awarded and supervised to obtain the data we will require to calibrate and verify the wellbore stability model.

4.5.4 Subtask 5.4 – Wellbore Stability Model Validation

As the laboratory work is being conducted, the data generated will be supplied to the subcontractor who is building the wellbore stability model. The data will be used to both calibrate and validate the model, as well as to guide the future laboratory experiments.

4.6 Task 6 – Seismic Modeling and Analysis

The JIP has a contract with WesternGeco to obtain existing three-dimensional seismic data in selected areas of the deep water GOM for review of the gas hydrate zones. These data will be used to conduct theoretical seismic modeling to provide input into developing protocols on how to acquire, record, and process seismic data to better image the gas hydrate zones in the deep water GOM. The seismic modeling should lead to the development of protocols for acquiring, recording, processing, and analyzing seismic data to better image the gas hydrate zones. The JIP will be developing laboratory test specifications on cores that will help acquire, record, process and interpret seismic data in the gas hydrate zones. Once the laboratory tests are specified, the JIP will contract a third party to conduct laboratory tests to generate data to help interpret seismic and petrophysical measurements in cores containing natural gas hydrates.

The seismic modeling and analysis study is designed to test the detection of and quantification of natural methane gas hydrates in sediments of the deepwater portion of the Gulf of Mexico using rock property inversion of pre-stack seismic data. Synthetic seismic modeling will be conducted on a series of generated earth models using rock physics in order to develop an improved process of seismic gas hydrate delineation and quantification.

4.6.1 Subtask 6.1 – Identify and Obtain Existing 3D Seismic Data (Completed)

During this research project, the JIP will determine the best ways to shoot, record, process and analyze seismic data to characterize the gas hydrates that are located in the deep water GOM. These protocols will be used to select sites for data collection in Phases II and III of this project. A contract has been awarded to WesternGeco to provide existing seismic data in six areas in the deep water GOM.

4.6.2 Subtask 6.2 – Theoretical Seismic Modeling

Virtually all of the seismic data shot in the deep water GOM has been optimized to find oil and gas formations deep below the mud line. Since gas hydrate deposits are located at or near the seafloor, it is likely that the seismic data that we will obtain will not have been optimized to image the seafloor and the gas hydrate zones that lie beneath the seafloor. WesternGeco has been contracted to conduct theoretical seismic modeling, using their 3-D data sets in the areas of interest. The objectives of the seismic modeling are to determine how seismic data must be shot, recorded, processed and analyzed to accurately image the naturally occurring gas hydrate deposits near the seafloor.

4.6.3 Subtask 6.3 – Protocol Development for Seismic Data

Once the geophysical modeling has been concluded, WesternGeco will prepare protocols that can be used in future research to shoot, record, process and analyze seismic data to better image the gas hydrate zones in the deep water GOM. As we proceed into Phases II and III of this project, we can discuss the protocols with various seismic and/or operating companies who will be shooting seismic in our areas of interest. Ideally, we can obtain additional 3-D seismic data shot using the protocols developed during this portion of our research.

4.6.4 Subtask 6.4 – Specify Seismic Data Laboratory Tests (Completed)

To calibrate seismic data and to improve analyses procedures, it is useful to have information concerning sonic travel times (both P-wave and S-wave) through any sediment that affects the interpretation of the seismic data. In our case, we would like to have laboratory data concerning how gas hydrate saturation in cores affects the acoustic properties of the core.

Using information from the JIP workshops, the technical teams have prepared specifications for laboratory tests to develop information needed by the JIP. The specifications were used to prepare the request for proposal in Task 6.5.

4.6.5 Subtask 6.5 – Seismic and Petrophysical Laboratory Tests

A request for proposal for conducting laboratory tests to generate data to help interpret the seismic and petrophysical properties of cores containing natural gas hydrates was prepared. Ten proposals were reviewed and Georgia Tech was selected to conduct the necessary laboratory work. We envision that the results of this laboratory work will be valuable in both the interpretation of seismic data, as well as in the development and analyses of wire line and MWD measurements.

4.7 Task 7 – Kinetics and Thermodynamics Analyses

We have conducted a comprehensive literature search to summarize existing information and data on gas hydrate kinetic and thermodynamic properties in porous media, as well as other gas hydrate topics. The resulting bibliographies can be accessed through the JIP website. We have determined the kinetic and thermodynamic data are needed by the models that are used to understand and predict the geologic, reservoir, and geomechanical behavior of formations containing natural gas hydrates. We have specified the laboratory tests required to measure the needed kinetic and thermodynamic data from cores containing gas hydrates required by the geoscientist and engineering modeling community. We have also specified the laboratory tests required to measure the needed physical and chemical data from cores containing gas hydrates required by the geoscientist and engineering modeling community. Finally, we are in the process of contracting with third parties to conduct laboratory experiments to obtain kinetic and thermodynamic data from cores containing natural gas hydrates, and to conduct laboratory tests to gather data on the physical and chemical properties of cores containing natural gas hydrates.

4.7.1 Subtask 7.1 – Literature Review of Hydrate Kinetic and Thermodynamic Properties (Completed)

Over the years, scientific data has been generated and published concerning both the kinetic and thermodynamic properties of gas hydrates. However, it is not clear how much data exist concerning how gas hydrates in porous media affect the properties of the porous media. As such, we have conducted a thorough investigation of what information lies in the published literature. We have searched journals in all possible disciplines and will look into Master Theses and Ph.D. Dissertations at various universities. The results of our literature search are posted on the JIP website at the following address.

http://qpext.chevrontexaco.com/QuickPlace/wwuexpl_gashydrates/Main.nsf?OpenDatabase.

4.7.2 Subtask 7.2 – Gas Hydrate Kinetic and Thermodynamic Data Analysis (Completed)

Eventually, models must be developed to allow engineers and geoscientists to analyze the present conditions in a natural gas hydrate deposit, and to predict the future behavior of the gas hydrates when pressures and temperatures change, or chemicals are injected. We need geologic, reservoir and geomechanical models concerning the behavior of formations containing natural gas hydrates. These models will need data – specifically, kinetic, thermodynamic and physical data measured in the laboratory in order to function properly. To design such tests, we held a Workshop with Geoscience and Reservoir modelers in May 2002 to find out what data they require for their models. The results from that workshop are posted on the JIP website and are presented in detail in a DOE report. The JIP has been using the results of that workshop to design a matrix for conducting the laboratory tests, and to plan our field data collection efforts in Phase II of this project. Our goal is to provide all the data required for existing and future models of natural gas hydrate deposits.

4.7.3 Subtask 7.3 – Specifications for Kinetic and Thermodynamic Laboratory Tests (Completed)

Using the results from the Modeling Workshop, we now know what kinetic and thermodynamic data are required by the geoscience and engineering models. Using this information, the Gas Hydrates Characterization Team has developed a core analyses test matrix. The matrix will be used to specify the laboratory tests and the desired results from such tests that will be of the most benefit to the geoscience and reservoir modeling communities. We are using the matrix to solicit input from various laboratories concerning the feasibility of generating the required data in a reasonable amount of time.

The Core Analyses Test Matrix is presented in Appendix A.

4.7.4 Subtask 7.4 – Specifications for Chemical and Physical Property Tests (Completed)

The Hydrates Characterization Team has also determined what physical and chemical data are required from laboratory measurements by the geoscientists and engineers who will be building and using the models. The Team has specified the laboratory tests and the required results from the tests in the Test Matrix that is given in Appendix A.

4.7.5 Subtask 7.5 – Laboratory Testing for Kinetic and Thermodynamic Properties

The Hydrates Characterization Team will recommend a contractor to run the desired kinetic and thermodynamic tests using cores containing natural gas hydrates. If the team determines it to be necessary, an RFP will be posted on the JIP website and proposals will be solicited. The best proposal(s) will be selected and the winning organization(s) will be subcontracted to conduct the laboratory work.

4.7.6 Subtask 7.6 – Laboratory Testing for Chemical and Physical Properties

The Hydrates Characterization Team will determine if an RFP to run the desired chemical and physical tests using cores containing natural gas hydrates is required. If required, the RFP will be posted on the JIP website and proposals will be solicited. The best proposal(s) will be selected and the winning organization(s) will be subcontracted to conduct the laboratory work. The DOE is funding, through other projects, many of the tests that the JIP require. The JIP will coordinate our activities with other programs to avoid duplication.

4.8 Task 8 – Determine Data Requirements for GeoModels

The Seafloor Stability Team took on the tasks of planning and soliciting interest in a geoscience/reservoir modeling workshop. A workshop on Modeling, Measurements and Sensors was held in May 2002 for geoscientists and reservoir engineers to determine data requirements for state of the art models. The results of the workshop were recorded in a DOE report and will also be included in a White Paper on data requirements for models. This information will be used to provide input on data collection planning for Phase II, and any possible Phase III of this project.

4.8.1 Subtask 8.1 – Form Geoscience/Reservoir Modeling Committee (Completed)

To analyze existing data concerning naturally occurring gas hydrate deposits, and to predict the behavior of these deposits as things change, geoscientists and reservoir engineers need to use models. In the case of formations with gas hydrates in the pore space, we need to learn both how to properly model this system and what data are required to improve accuracy. The JIP held a Modeling, Measurements, and Sensors Workshop in May 2002 to solicit input from the modeling community.

4.8.2 Subtask 8.2 – Plan a Geoscience/Reservoir Modeling Workshop (Completed)

The Seafloor Stability Team took on the task of planning a workshop to allow professionals who do geoscience and/or reservoir modeling to discuss the issues surrounding data needs and data collection methods for the models. The team met several times to set the agenda, identify likely participants, solicit interest, solicit keynote speakers, and finalize the plans for the workshop. Again, the purpose of the workshop was to get together those geoscientists and engineers who are the experts in modeling of sediments containing natural gas hydrates, and let them tell the JIP what data they need to run their models. The workshop was also designed to obtain information on measurement techniques and sensors needed to better measure the properties of naturally occurring gas hydrates.

4.8.3 Subtask 8.3 – Conduct a Geoscience/Reservoir Modeling Workshop (Completed)

The workshop was held in March 2002. The results from the workshop will affect the planning for the remainder of this research project. The workshop was designed to simulate discussion and ideas concerning the data requirements for all modelers, the measurement techniques that will provide the best data, and the need for new and better sensors for making measurements. From this workshop, the JIP learned the data requirements most needed from the participants, and the relative importance of each data item or data set. The JIP will use the output from the workshop to prioritize the data we can collect in our field work. The results from the workshop have been documented in detail. There is a workshop report on the JIP website, and a DOE report on the workshop has been written and submitted to the DOE.

4.8.4 Subtask 8.4 – Write a Geoscience/Reservoir Modeling White Paper

The results from the Modeling, Measurements, and Sensors Workshop were documented and placed on the JIP website. In addition, a DOE report on this and the other two workshops was written and submitted to the DOE. However, to guide data collection in Phase II of this project, the Seafloor Stability Team will prepare a White Paper on the data required by geoscientists and engineers who develop and use models to understand the behavior of sediments containing gas hydrates. The White Paper will use the results of the workshop, and provide a guide for the JIP as it makes plans to gather data in both the laboratory and the field.

4.8.5 Subtask 8.5 – Develop Data Collection Requirements for Phase II

As we develop data collection plans for Phase II of this project, the White Paper and the results from the Modeling, Measurements and Sensors Workshop will provide valuable input into the planning process. The Seafloor Stability Team will be instrumental in the planning processes, so that we are assured of maximizing our efforts at collecting data that will be useful to the modeling community.

4.9 Task 9 – Develop Drilling and Coring Test Plans

The Drilling and Coring Team planned and solicited interest in the Drilling, Coring and Core Analysis Workshop. We held the workshop in May 2002. The results of the workshop were included in a DOE report and will be used to document current drilling practices when drilling in areas where hydrates are known to or thought to exist. The workshop will also help us to develop scenarios for drilling and coring gas hydrates in deep water, and to determine costs and risks of the various scenarios. Finally, we plan to develop guidelines and issue protocols to be used when drilling or coring through natural gas hydrates, then prepare detailed plans for drilling and coring gas hydrates in deep water.

4.9.1 Subtask 9.1 – Form a Drilling and Coring Committee (Completed)

Currently, we do not know the best way to drill through or core through formations containing natural gas hydrates. Several methods have been discussed and costs have been estimated, but substantial progress is required to meet the objectives of this research project while keeping the research budget reasonable. As such, the Drilling and Coring Team was charged with organizing and conducting a workshop concerning drilling and coring practices through formations containing gas hydrates in deep water.

4.9.2 Subtask 9.2 – Plan a Drilling and Coring Workshop (Completed)

The Drilling and Coring Team met several times to plan the Drilling and Coring Workshop, to set the agenda, identify likely participants, solicit interest, and find keynote speakers. The purpose of the workshop was to get the drilling community together to discuss the important issues and help develop plans that can be used in Phase II of this project.

4.9.3 Subtask 9.3 – Conduct a Drilling and Coring Workshop (Completed)

The Drilling and Coring Workshop was held in May 2002. The results of the workshop have been instrumental in organizing the remaining tasks in Phase I, and for planning Phase II. The workshop was organized to allow participants to discuss the state of the art in drilling and coring practices in deep water, and how those practices are affected by the presence of natural gas hydrates. Safety issues were also thoroughly discussed and documented. In addition, time was spent looking at relevant drilling and coring issues from the Mallik project and other projects of interest. The results from the Drilling and Coring Workshop are documented in detail on both the JIP website and in the DOE report.

4.9.4 Subtask 9.4 – Publish a White Paper Documenting Current Practices

In addition to the workshop report on the JIP website and the DOE report documenting the results from the workshop, the Drilling and Coring Team will be preparing a White Paper concerning how to best drill and core through formations containing natural gas hydrates. The importance of this task cannot be overstated. Safety is the primary concern in all deepwater operations. This White Paper will prove to be extremely beneficial to all parties associated with this research project.

4.9.5 Subtask 9.5 – Develop Scenarios for Drilling and Coring Gas Hydrates

One important result from the Drilling and Coring Workshop was the discussion of scenarios concerning how we can best drill through and core formations containing gas hydrates. These discussions will help the Drilling and Coring Team prepare plans for drilling and coring wells during Phase II of this project. In addition to the workshop, members of the Drilling and Coring Team have been reviewing data and specifications for several vessels that could be used in Phase II of the project.

4.9.6 Subtask 9.6 – Conduct a Cost/Risk Analyses on the Various Scenarios

All feasible scenarios concerning how the JIP can drill and core wells during Phase II of this project are currently being defined and analyzed to determine the costs and risks associated with each scenario. Various options will be discussed with the Minerals Management Service (MMS) in New Orleans during early 2003.

4.9.7 Subtask 9.7 – Develop Drilling and Coring Protocols for Gas Hydrates

From the workshop and other meetings held by the Drilling and Coring Team, the team is close to recommending a likely scenario for drilling and coring natural gas hydrates in deep water, that will lead to a logical field data collection process in Phase II of this project. Once the drilling and coring protocols and procedures are approved by the MMS, they will be documented and put out to industry for comments.

4.10 Task 10 – Core Handling and Core Tests

We have conducted a detailed literature search to determine what information is required from tests of cores containing gas hydrates. We are in the process of preparing protocols for coring, core handling, core preservation, core transport, and core testing for cores containing natural gas hydrates. Much of the information the JIP needed was presented and recorded in the Drilling and Coring Workshop in May 2002, which was documented in a DOE Report.

4.10.1 Subtask 10.1 – Core Sample Information

During Phase II of this project, we will be cutting cores in formations potentially containing natural gas hydrates. To prioritize how the core is handled, preserved, transported and distributed, the Drilling and Coring Team have been working on determining the exact core tests that will be required, and how much core will be required to conduct those tests. It was clear from the discussions during the Drilling and Coring Workshop that advanced planning will be crucial to the coring and core handling portion of Phase II.

To design core sampling and core presentation work plans, the JIP must develop a flow chart that clearly enumerates what measurements will be needed, where, when and by what process they will be obtained. Only after knowing exactly how much core is needed, where the core is needed and for what purposes the core will be used can the JIP come up with a realistic plan to preserve and transport that core. Several gas hydrate coring projects, Mallik 2L-38, ODP Leg 204, BP's Arctic Project, and Anadarko's Arctic Project, have just been completed or will be conducted soon. The JIP should watch these projects very closely and apply all best practices.

Preserving core temperature is critical. There was some concern identified during the Drilling and Coring Workshop, however, over the use of liquid nitrogen to accomplish this due to the potential of the nitrogen to change the hydrate properties due to molecular interaction. Transportation of pressurized core samples should be by land or sea and not by air. Once the core is taken, there was a high degree of interest in instrumenting the hole and surrounding seafloor and gathering additional data over time. This should help integrate the core data and provide information on the dynamics of hydrate sediments.

4.10.2 Subtask 10.2 – Core Sample Protocols

The results from the Drilling and Coring Workshop clearly showed that protocols already exist in the Ocean Drilling Program and other programs, such as the Mallik project, concerning how to core, handle, preserve and transport cores containing natural gas hydrates. The JIP plans to use existing protocols as much as feasible during Phase II of the project. We will combine the ODP protocols with information we obtain elsewhere and will prepare comprehensive plans that will be used in Phase I of this project for core handling, preservation and transportation.

To further assist the JIP in writing core sample protocols, RFP No. 1 entitled "The Effect of Thermal History on Properties of Hydrate Core Samples" was placed on the JIP website. This project was initiated as a direct result of attendee feedback at the workshops held in May 2002. The objectives of this work are as follows:

1. Determine the effect of pressure-temperature changes during core recovery on core properties, specifically seismic, but other physical and mechanical properties should also be evaluated;

2. Determine the properties of sediments containing gas hydrates covering the expected range of sediment and hydrate types in the Gulf of Mexico; and

3. Develop protocols for measuring properties of cores taken from the Gulf of Mexico that will be collected during Phase II of this project.

After reviewing all proposals submitted as a result of RFP No. 1, Georgia Tech University was chosen to do the work. As of September 2002, the contract details were being finalized. The work has already commenced.

Two other RFPs were posted on the JIP website during April – September 2002. These RFPs covered "Drilling and Coring Well Plan" and a "Core Handling and Testing Plan". Proposals have been received for each RFP and the selection of the contractors for these two tasks will be completed in January 2003.

4.11 Task 11 – Select Locations for 3 Field Tests

Using the database we have created and all available information from the three workshops we have held, the JIP will develop a short list for potential field test sites. The short list will be provided to WesternGeco so that they can determine what seismic data are available and begin looking at how these areas fit the requirements of the JIP and the DOE.

4.11.1 Subtask 11.1 – Develop Short List of Field Test Sites (Completed)

During Task 3 of this project, the JIP held a Data Collection Workshop and developed a website to store information concerning gas hydrate deposits in the deep water GOM. The information obtained during the workshop has been combined with published data and knowledge held within the JIP participants to develop a short list for potential field test sites. The original short list is given in **Table 4.2**. This list will be reviewed by an outside committee, and could be altered as more information is obtained and more experts are consulted.

4.11.2 Subtask 11.2 – Comprehensive Database Evaluation

Currently, 25 sites have been selected for potential field test sites. WesternGeco has pulled the 3-D data that they have on these sites to determine if the quality of the seismic in these areas is sufficient. The JIP is thoroughly evaluating the data in the database to evaluate each site. The

JIP plans to obtain additional data from service companies, operating companies, academia and government organizations to assist our evaluation of the most promising sites.

4.11.3 Subtask 11.3 – Additional Data Analysis

As the JIP continues to evaluate the data and determine the best sites for field tests, it will become evident that we are missing certain data items or data sets that could be of benefit to our analyses. We will use this knowledge to help us plan the data collection programs for future field tests. It is important to not only collect accurate data, but we must also know and prioritize our data collection efforts to be of maximum benefit to the geoscientists and engineers who will be using the data.

4.11.4 Subtask 11.4 – Selection of 3 Field Test Sites

Using all available information, especially the results from the seismic modeling studies being conducted by WesternGeco, the JIP will need to select three or more sites for conducting field tests during Phases II and III of this project. Site selection will be critical to our success and should be based upon costs, risks and the ability of our project to succeed. Obviously, the operators of the sites selected will need to be contacted and included in our planning processes.

4.11.5 Subtask 11.5 – Prioritize Field Test Sites

Since only a limited number of test sites will be drilled in Phase II, it will be necessary to prioritize the field test sites in order of preference. We will be conducting a pilot test during Phase II so we can test our protocols, our methodology and our technology. It is important that the best site be chosen to maximize our chances of success. Costs, risks and the quality of the technical information must all be evaluated to prioritize the field test sites.

4.12 Task 12 – Document Results and Conduct Conference on Field Test Plans

Semi-Annual and topical research reports will be written to document this project. We plan to hold a 2-day conference to solicit input from industry on the plans for conducting field tests. In addition, technical papers will be written and presented at various technical meetings as warranted. The reports that will be written during Phase I of this project are given in **Table 4.2**.

Table 4.2 – Reports to be Written During Phase I

	Subtask	Title	Due Date
1	3.3	Results from the Data Collection Workshop, the Drilling and Coring Workshop, and the Modeling, Measurements and Sensors Workshop.	Nov. 2002
2		Semi-Annual Report for October 2001 – March 2002	Jan. 2003
3		Semi-Annual Report for April – September 2002	Jan. 2003
4	6.3	Protocols for Seismic Data and Acquisition and Processing	TBD
5	8.4	Geoscience/Reservoir Modeling White Paper	TBD
6	9.4	Current Drilling Practices White Paper	TBD
7	12.0	Results from the Field Testing Workshop	TBD
8		Final Report for Phase I	Dec. 2003

5.0 Phase II – Initial Core and Well Log Collection and Analyses

Phase II of this project will commence in 2003.

5.1 Task 1 – Research Management Plan

We will develop a work plan and supporting narrative that concisely addresses Phase II of the project as set forth in the Technical Proposal and DOE Contract. The Research Management Plan ("The Plan") will provide a concise summary of the technical objectives and the technical approach for each Task and, where appropriate, each Subtask. The Plan will provide detailed schedules and planned expenditures for each Task using graphs and tables as needed. The Plan will contain all major milestones and decision points.

5.2 Task 2 – Project Management and Oversight

A Project Manager will be appointed by ChevronTexaco to manage Phase II of the project for the JIP. The Project Manager will supervise the technical committees and the contractors and will handle the day-to-day operation of the project. The Project Manager will report verbally and in writing to the DOE as needed.

5.3 Task 3 – Validation of New Gas Hydrate Sensors

We will meet with all interested parties to discuss the new sensors that are being developed (assuming that someone has taken on this task). Once the prototype sensors are ready, we will plan to test the sensors in our data wells and to produce and distribute protocols for using the new sensors.

5.4 Task 4 – Validation of the Wellbore Stability Model

The wellbore stability model will be revised using laboratory data and will be validated using all available information. Changes or improvements will be made and the model will be distributed for use by organizations that are drilling wells in the deep water GOM.

5.5 Task 5 – Core and Well Log Data Collection – Area A

Using our best area selected during Phase I, we plan to drill twin wells in the most favorable location for gas hydrates in Area A. Well A-1 will be drilled without well control and will gather drilling, MWD and open hole logging information. Well A-2 will be drilled with well control and will gather drilling, MWD, core and open hole logging information. The wells will be surveyed and the core will be sent to laboratories for analyses. We will then drill Well A-3 in the least favorable location for gas hydrates in Area A, and obtain appropriate core, logging and drilling data. The drill and coring plan for Phase II will be modified to make full use of the selected drill ship and scientific staff.

5.6 Task 6 – Data Analysis – Area A

We will conduct appropriate laboratory tests of cores from Wells A-2 and A-3 to generate data to assist in the interpretation of the seismic data, the petrophysical properties, the sedimentology, the distribution of the hydrates in the cores, and the chemical and physical properties of the cores. We will also analyze data from the MWD and open hole geophysical logs from Wells A-1, A-2, and A-3. Finally, we plan to integrate log, core and seismic data from all three wells.

5.7 Task 7 – Update Models, Plans and Protocols

Using all of the new data from Area A, we will update all theoretical models, as well as all protocols concerning drilling, coring, and seismic operations. These protocols and models can be used to update plans for drilling future data collection wells.

5.8 Task 8 – Integrate New and Old Seismic Data in Test Analyses

The results of the previous data collection and lab analysis effort may indicate changes to or improvements in the type and method on seismic data needed for natural gas hydrate collection. Based on these results, we will determine the need for and collect additional seismic data in the test areas and integrate these new data into our existing database.

5.9 Task 9 – Conference and Information Transfer

We plan to write topical and annual reports, plus a final report and appropriate technical papers to document the work we will do during this project. We will also hold a 2-day technical conference to present all information to industry and solicit opinions and interest in continuing with Phase III.

5.10 Phase III – Comprehensive Core and Well Log Data Collection and Analyses (2005-2006)

Phase III is not included in this research project. If Phase II is successful and all parties agree to continue this research, Phase III will be a continuation of Phase II in more gas hydrate sites in the deep water GOM. If all parties agree to proceed with Phase III, a detailed technical and cost proposal will be prepared and presented.

6.0 Experimental

No experimental work was done in this period.

7.0 Conclusions

Additional information and input to the project was gained from the workshops and will be valuable in planning the balance of the project.

Testing of fine grain hydrate sediments using lab prepared material is not practical using methane as the hydrate former. Another means will have to be employed to obtain the data needed on the soil types that should be found in the GOM.

Drilling for cores and logs in hydrate areas can be done without a raiser.

It was clear that there is a significant opportunity for the JIP to improve the state of knowledge of naturally occurring gas hydrates, by gathering in situ seafloor and/or wellbore data, via downhole instrumentation, over time. There is an almost total lack of in situ data taken over an extended period of time. The use of instrumentation on the seafloor and/or in wellbores could provide valuable insight into the stability of hydrates over time, and a better understanding of the process of disassociation.

The original plan called for drilling three data collection wells using conventional deepwater drill ships and gas exploration protocol requirements. However, due to the success of the Ocean Drilling Project (ODP) in conducting scientific studies in gas hydrate areas, it is likely the JIP's approach to the data collection wells will mirror the ODP approach. Thus, it should be possible to drill considerably more than three data collection wells during Phase II within the budget limitations.

8.0 References

No external references were used in this report.

APPENDIX A

TEST MATRIX FOR CORE ANALYSES

CASE: Fresh Water in Pores, No Salt, Pure Methane Hydrate Assumed

Geothermal gradient (°C/100 meters)	Variable
Pore water salinity (wt %)	0

Hydrate Stability Zone Characteristics	Water Depth (feet)				
	2000'	3000'	4000'	6000'	8000'
Thickness (mbsf)	154	452.5	693	1140	1602
Thickness (ft below seafloor)	505	1485	2274	3740	5256
Hydrostatic pressure @ seafloor					
$P_{seafloor}$ (psi)	907	1353	1800	2691	3584
$T_{seafloor}$ (°C)	6.3	4.9	4.2	3.3	2.7
Hydrostatic pressure @ BHSZ					
P_{BHSZ} (psi)	1123	2009	2810	4363	5938
T_{BHSZ} (°C)	10.4	15.3	18.1	21.8	24.4
Average hydrostatic HSZ Pressure (psi)	1015	1681	2305	3527	4761
Average HSZ Temperature (°C)	8.4	10.1	11.2	12.6	13.6

For 2000 feet WD	2.68	°C/100 meters
For 3000 feet WD	2.29	°C/100 meters
For 4000 feet WD	2.02	°C/100 meters
For 6000 feet WD	1.63	°C/100 meters
For 8000 feet WD	1.35	°C/100 meters

Experimental Program Needed to Fulfill GOM JIP Objectives

Assuming sI methane hydrate

Refer worksheet "HSZ calculation" for details

						Samples: Sediment type, Porosity, Methane hydrate pore volume saturation				
Water Depth (ft)	**Predicted Thickness of Methane HSZ (ft below seafloor)**	**Average P-T Condition in Methane HSZ**	**Depth below seafloor corresponding to average P-T condition (ft)**	**Triaxial Effective Confining Pressure**	Sand, 35% porosity, 0% hydrate in pore space	Sand, 35% porosity, 25% hydrate in pore space	Sand, 35% porosity, 60% hydrate in pore space	Silt, 45% porosity, 15% hydrate in pore space	Clay, 55% porosity, 5% hydrate in pore space	Clay, 55% porosity, 0% hydrate in pore space
3000	1485	1700 psi hydrostatic 10°C	785 ft	None	**X**	**X**	**X**	**X**	**X**	**X**
				Representative for depth below seafloor	**X**	**X**	**X**	**X**	**X**	**X**
6000	3740	3525 psi hydrostatic, 12.5 °C	1865 ft	None	**X**	**X**	**X**	**X**	**X**	**X**
				Representative for depth below seafloor	**X**	**X**	**X**	**X**	**X**	**X**
				Media for testing:	**N.A.**	**methane**	**methane**	**?**		**N.A.**
					N.A.		**THF**	**THF**	**THF**	**N.A.**

Sand Specification:
Fine quartz, Average grain size ~ 75-100 microns

Clay Specification:
Water saturated Illite, Kaolinite/Montmorillonite mixture, Average grain size ~ 2-3 microns

Silt Specification: Quartz silt, Average grain size ~ 20 microns; it should be saturated with water

Issues to resolve before release for RFQ

1) Grain size calibration to the GOM
2) Porosity requirements for the GOM

Testing plan

1) Strength test (triaxial rock properties)
2) Acoustic properties triaxial
3) Thermal testing and properties (low priority)

Tests Needed on Each Sample at Each P-T Condition

Property	Specific Tests	Sample Type
Mechanical (Young's Moduli, Poisson's ratio, compressibilities, compaction coeffs., cohesive strengths, grain/ cement interactions, failure-stability surfaces, constitutive behaviors, etc.)	Longitudinal and lateral stress-strain curves Tensile, shear, and compressive strengths Moduli (Young's, Shear, Bulk) through both static and dynamic measurements Elastic-Plastic Transition, Failure/stability envelopes (Mohr-Coulomb) Loading-path (hydrostatic, uniaxial, triaxial) dependent compaction coefficients Volume-Pressure compaction curves	Stable Stable, Decomposing, Decomposed Stable Stable, Decomposing, Decomposed Stable Stable, Decomposing, Decomposed
~~**Dissociation kinetics**~~ ~~(rates, i.d. rate limiting step, intrinsic kinetic dissociation rate constants)~~	~~Subject samples to P-T-time paths simulating (a) hot fluids flowing thru wellbore~~ ~~& measure gas evolution and track dissociation front through X-ray CT scan~~ ~~Repeat with P-T-time path simulating core recovery~~	~~Decomposing~~ - ~~Decomposing~~
Thermal (parameters needed for heat transfer modeling)	Thermal Conductivity Thermal Diffusivity Heat Capacity Thermal expansivity	Stable Stable Stable Stable
Seismic	P and S-wave velocities Acoustic impedance	Stable
Electrical	Resistivity Real permittivity at microwave frequencies (gives volumetric free water fraction)	Stable Stable
Geologic/ Rock Physics	Distribution of hydrates within sediments - understanding spatial relationships (pore filling vs. grain boundaries vs. structurally located): SEM, MRI, etc.	Stable

May be looked at by one of the JIP member companies

What frequency range should we consider? <2 MHz, about 500 MHz, about 1,100 MHz, and >20,000 MHz ?