

Oil & Natural Gas Technology

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Quarterly Research Performance Progress Report

(Period ending 06/30/2015)

Advanced Hydrate Reservoir Modeling Using Rock Physics Techniques

10/1/2012 – 3/31/2016

Submitted by:

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Executive Summary

This research effort focuses on developing and refining techniques that integrate rock physics modeling, amplitude analysis, and spectral decomposition to characterize complex gas hydrate reservoirs. The expected outcome of the research efforts will be an enhanced ability to quantitatively evaluate and prioritize potential gas hydrate accumulations that may be selected as exploration drilling targets based on 3-D seismic data.

On March 19th, Fugro Multi-Client Services agreed to in principle to provide a research license for these 3D seismic data in the Lund and The Elbow protraction areas, offshore Florida, for this consulting project. The dataset cover a large area of the United States' Lund and The Elbow protraction areas in the Eastern Gulf of Mexico. The data were received and loaded for interpretation on April 22nd. Interpretation and screening for potential gas hydrate deposits was the principal effort in this quarter. On June 1, Fugro Multi-Client Services sold the seismic data to Spectrum ASA. On June 29th, we were informed that Spectrum ASA would honor an effective research license of the seismic data for this project.

Accomplishments to date

- Reviewed related scientific/industry research efforts.
- Identified relevant research concepts.
- Investigated well logs data in WR 313 and GC955
- Selection of initial rock physics model.
- Progress on selection of possible statistical classification techniques.
- Contact with communities of interest after the award announcement. USGS, Colombian Petroleum Institute, KIGAM, Guanzhou Marine Geological Survey, Shell, BP, Chevron, Petronas, National University of Singapore, and Texas A&M University
- Continued professional development for Dr. Zhang, building on recent past work.
- Received in-kind contribution Jason Workbench Suite of petrophysical and inversion software to develop analytical routines.
- Purchased Hampson Russell AVO and inversion software that can be used in this project
- Modeling mixtures of methane and thermogenic gas hydrate signatures against flux and geothermal gradients and depositional architecture.
- Presentation of Poster showing research progress at Gordon Research Conference in March, 2014.
- Researched attenuation concepts
- Preparation of oral talk for International Conference on Gas Hydrates.
- Negotiated donation of seismic lines in WR 313 and GC955 by CGG for use in this project.
- Presented oral talk at International Conference on Gas Hydrates in Beijing
- Agreement in principle for the use of approximately 12900 sq km of 3D seismic data in the Lund and The Elbow protraction areas, offshore Florida.(Exhibit 1).
- Agreement reached for the use of 3D seismic data in the Lund and The Elbow protraction areas.
- Screening of 3D data for potential gas hydrate targets.
- Use of the data for this project was secured from Spectrum ASA after they became the new owners of the data.

Progress, Results, and Discussion Summary of technical progress

The project was postponed for the period January 1, 2013 to September 30, 2013. Task Groups 1 (Project Management and Planning) and 2 (Project Initiation) were completed prior to this reporting period. Work was also done on Task Group 3 (Development of Project Research Concepts) prior to the work hiatus. The project restarted with continuation of work within Task Group 3 and Task Group 4.

Because of difficulties getting permission to use 3D seismic data in the area of interest, a second no-cost extension was granted that extends the research project until March 31, 2016.

Approximately 12,900 sq km of 3D seismic data in the United States' Lund and The Elbow protraction areas in the Eastern Gulf of Mexico was secured for this project. The large seismic dataset was screened for potential gas hydrate deposits. Several potential targets were identified. One of the principal potential gas hydrate targets is shown on Figures 1 and 2. The potential gas hydrate deposit is an anomalously fast sand about 30 sq km in area and approximately 24 m thick, about 830 m below sea floor, at a water depth of 3120 m. Mississippi Fan channels extend across the survey area. Modern seafloor channels are seen on the present day seabed and shown on Figure 1. Thick sequences of buried channels extend through the inferred gas hydrate stability zone. The base of gas hydrate stability can often be approximated by the depth below seafloor of topmost free gas. One of the challenges for interpreting a gas hydrate petroleum system in this area is that the sediments are mostly flat lying with little indications of gas. The potential gas hydrate deposit is along a singular deep-seated fault. Variations of amplitude strength appear to be effects of pore-fill rather than lithologic amplitude. That said, there is no clear free gas leg. The amplitudes deeper than 3950 m, say at 4063 also not have a clear signature of free gas pore fill, raising conjecture that they could represent at Structure H hydrocarbon fill. If the main potential gas hydrate target is near the base of methane hydrate stability, it suggests that the geothermal gradient is approximately 23° C/km (Figure 3).

Future work in next reporting period

- Characterize a gas hydrate petroleum system for the study area
- Identify gas hydrate targets
- Begin gas hydrate reservoir modeling research with the data

Changes or Problems

Because of delays in securing a suitable data set for the research, a second no-cost extension was granted until March 31 2016.

Although there are interpretation questions outstanding, we believe that we have identified potential gas hydrate deposits in the Eastern Gulf of Mexico seismic data set. As long as interpretation suggests the absence of potential gas hydrate deposits data set, there should be no problems to complete the research as envisioned. It would have, however, been far preferable to have received permission to use the 3D data that had been licensed to the Gulf of Mexico Gas Hydrate JIP Leg II project.

Software and work commitments from CGG are still outstanding issues. CGG has indicated that it is likely to not support the project with Jason Workbench software and technical advice.

Participants and Other Collaborating Organizations

	Zijian Zhang, Geophysicist, Fugro Employee	Dan McConnell, Principal Investigator, Fugro Employee	Greg Nash, Consultant Geoscientist, Fugro Employee
Nearest month worked this reporting period	0	1	1
Collaboration outside USA	Not this reporting period	Not this reporting period	None this reporting period
Travel outside USA to communities of interest	Guangzhou, China May and June 2015	None this reporting period	None this reporting period

Special Reporting Requirements

None this quarter.

Budgetary Information

\$117,062 has been spent from a budget allocation of \$213,444 to date. The federal share of the costs to date is \$93,650 and the cost sharing is \$23,412. The federal share of the costs per this reporting period is \$25,686 and the cost sharing is \$6,421.

- 1. Survey Name:** Florida 3D, 516 blocks; as shown on the map.
Consisting of
1. PSTM and PSDM full stack data
 2. Acquisition report
 3. Processing report for PSTM and PSDM

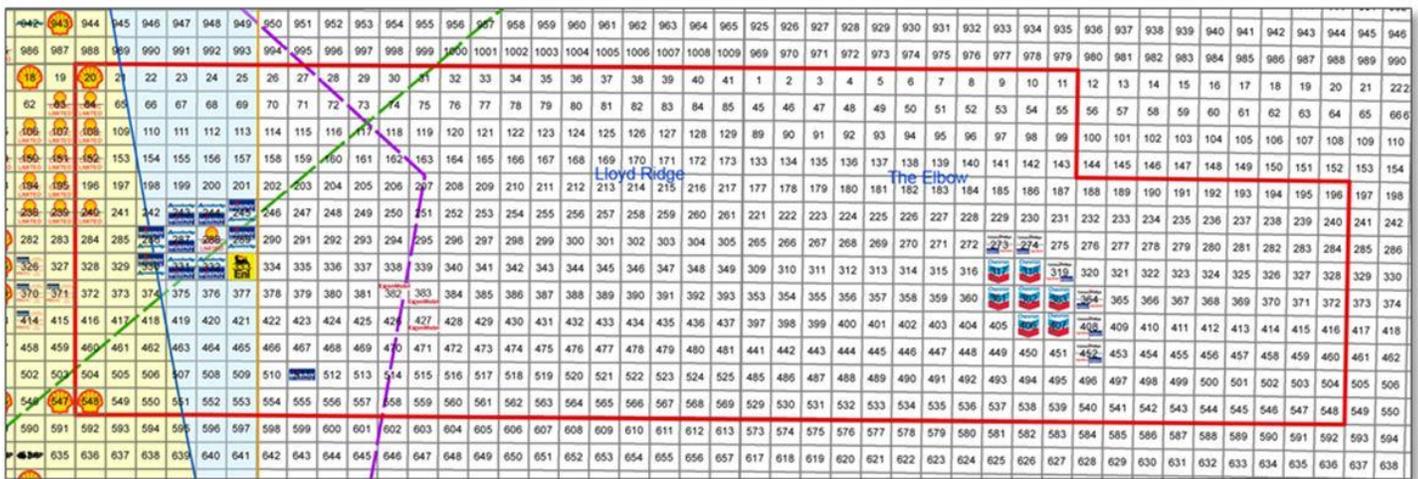
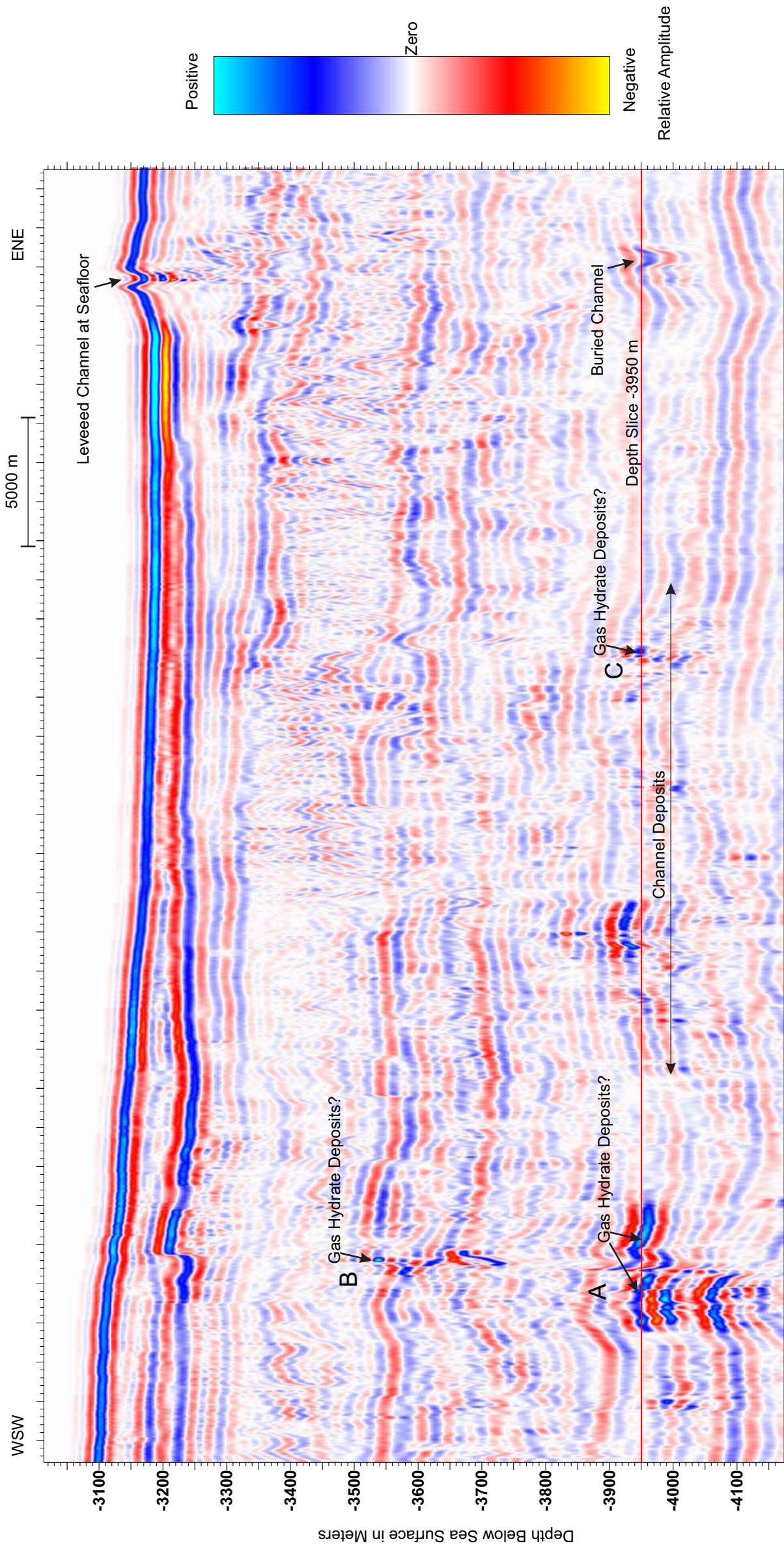


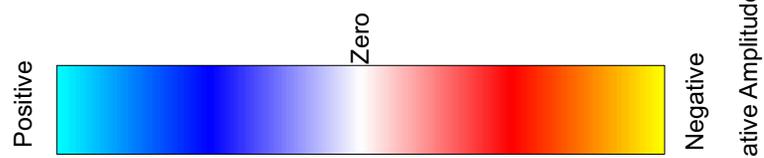
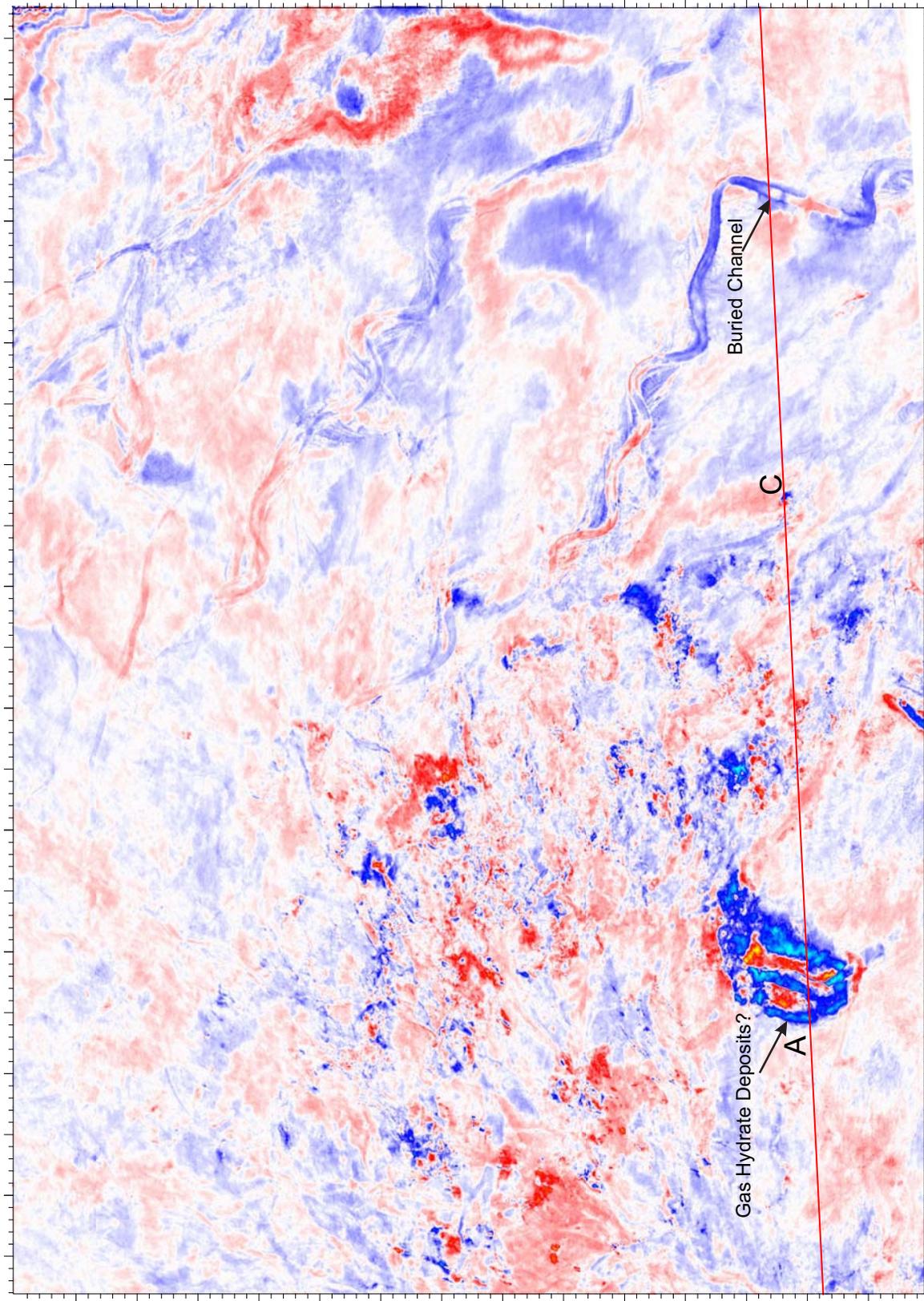
Exhibit 1. Extents of 3D Seismic Data Made Available to the Research Project



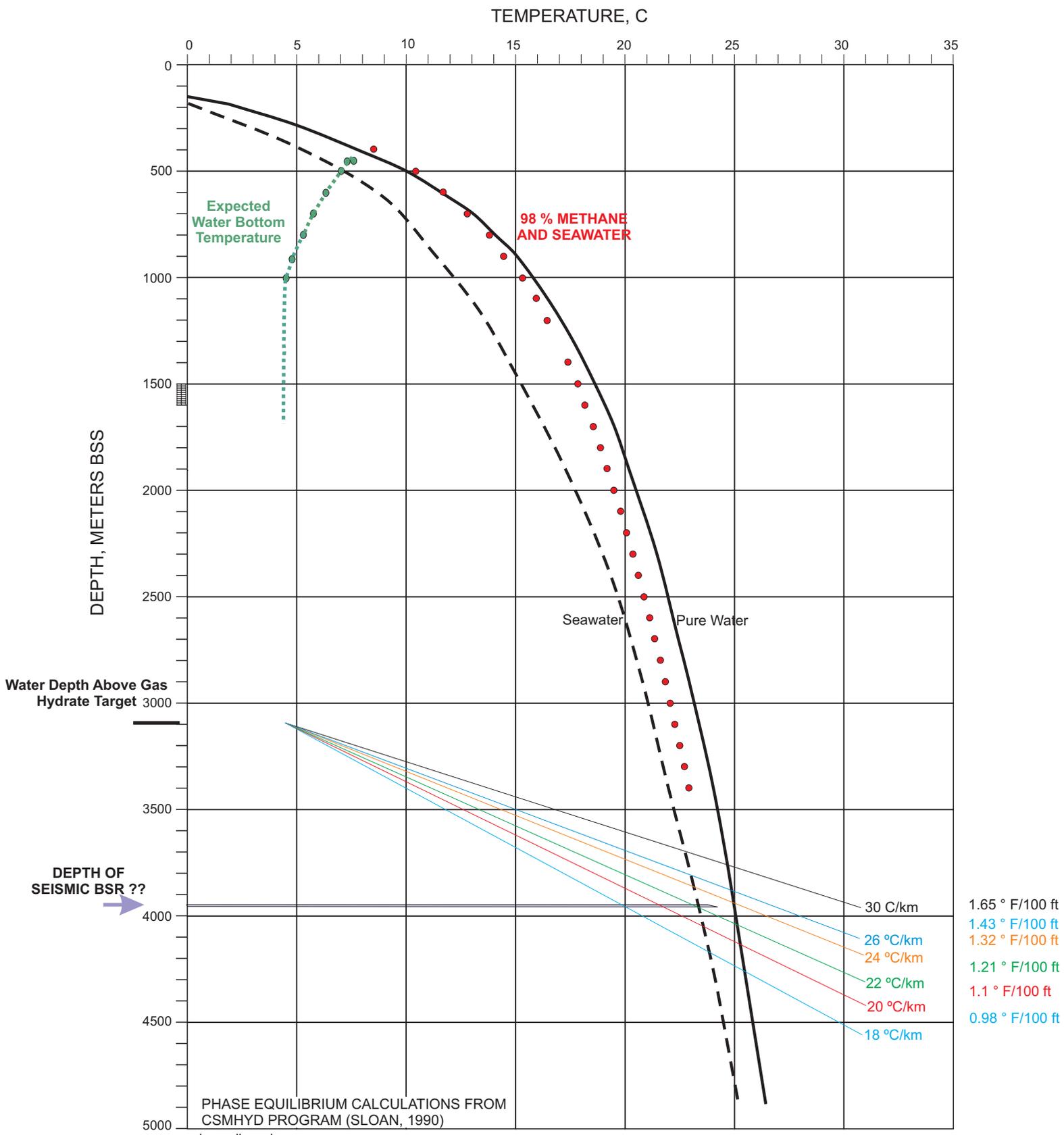
Seismic Line Showing Possible Gas Hydrate Deposits
 Lloyd Ridge Protraction Area, Gulf of Mexico



5000 m



Depth Slice -3950m Showing Possible Gas Hydrate Deposits
Lloyd Ridge Protraction Area, Gulf of Mexico



PHASE EQUILIBRIUM FOR 100% METHANE IN PURE WATER AND SEAWATER AND 98% METHANE AND SEAWATER SHOWING GEOTHERMAL GRADIENT INTERSECTS AT POSSIBLE GAS HYDRATE TARGET

Figure 3

Exhibit 2 Milestone Status

Milestone 1, Task 1 was completed November 14, 2012
Milestone 2 is outstanding.

Baseline Reporting Quarter	Budget Period 1												
	Q1 2012		Q2 2013		Q3 2013		Q4 2013		Q1 2013		Q2 2014		
	Sept-Dec 2012	Cumulative Total	Jan-Mar 2013	Cumulative Total	April-June 2013	Cumulative Total	June-Sept 2013	Cumulative Total	Sept-Dec 2013	Cumulative Total	Jan-Mar 2014	Cumulative Total	
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Baseline Cost Plan	7114	16226	23340	0	23340	0	23340	0	23340	17135	40475	11800	52275
Federal Share	1778	4057	5835	0	5835	0	5835	0	5835	4284	10119	2950	13069
Non-Federal Share	8892	20283	29175	0	29175	0	29175	0	29175	21419	50594	14750	65344
Actual Income Cost													
Federal Share	7114	16226	23340	0	23340	0	23340	0	23340	17135	40475	11800	52275
Non-Federal Share	1778	4057	5835	0	5835	0	5835	0	5835	4284	10119	2950	13069
Total Incurred Costs	8892	20283	29175	0	29175	0	29175	0	29175	21419	50594	14750	65344
Variance													
Federal Share	0	0	0	0	0	0	0	0	0	0	0	0	0
Non-Federal Share	0	(0)	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Total Variance	0	0	0	0	0	0	0	0	0	0	0	0	0

Baseline Reporting Quarter	Budget Period 2												
	Q3 2014		Q4 2014		Q1 2014		Q2 2015		Q3 2015		Q4 2015		
	April - June 2014	Cumulative Total	June-Sept 2014	Cumulative Total	Sept-Dec 2014	Cumulative Total	Jan-Mar 2015	Cumulative Total	April-June 2015	Cumulative Total	July-Sept 2015	Cumulative Total	
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	
Baseline Cost Plan	5504	5779	0	5779	12000	69779	103437	33658	137096	33658	170755	33659	170755
Federal Share	1376	14445	0	14445	3000	17445	25860	8415	34274	8415	42689	8415	42689
Non-Federal Share	6880	72224	0	72224	15000	87224	129297	42073	171370	42073	213444	42074	213444
Actual Income Cost													
Federal Share	5504	5779	0	5779	3233	61012	67964	6962	93650	25686	93650	33659	93650
Non-Federal Share	1376	14445	0	14445	808	15253	16991	1738	23412	6421	23412	8415	23412
Total Incurred Costs	6880	72224	0	72224	4041	76265	84955	8690	117062	32107	117062	42074	117062
Variance													
Federal Share	0	0	0	0	(8767)	(8767)	(35473)	(26706)	(43445)	(7972)	(43445)	(33659)	(77105)
Non-Federal Share	0	(0)	(0)	(0)	(2192)	(2192)	(8869)	(6677)	(10863)	(1994)	(10863)	(8415)	(19277)
Total Variance	0	0	0	0	(10959)	(10959)	(44342)	(33383)	(54308)	(9966)	(54308)	(42074)	(96382)

Exhibit 3 Cost Plan

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