

Oil & Natural Gas Technology

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

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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 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 2009 – September 2009, the JIP concentrated on:

- Conducting the LWD Cruise
- Analyzing the LWD data;
- Conducting a Workshop to present the LWD data and discuss the plan for 2010 and the next phase of the JIP..

More information is available on the JIP website.

<http://gomhydratejip.ucsd.edu/>

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1.0 Introduction

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

Based on 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 based on 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 deepwater GOM using seismic, core and logging data. **Phase III** of the project began in September of 2007 and will focus on obtaining logs and cores of hydrate bearing sands in the GOM.

1.4 Research Participants

In 2001, Chevron organized a Joint Industry Participation (JIP) group to plan and conduct the tasks necessary for accomplishing the objectives of this research project. As of September 2009, the members of the JIP were Chevron, Schlumberger, ConocoPhillips, Halliburton, the Minerals Management Service (MMS), Total, JOGMEC, Reliance Industries Limited, The Korean National Oil Company (KNOC), and StatoilHydro.

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 2009.

1.6 Purpose of This Report

The purpose of this report is to document the activities of the JIP during April 2009 – September 2009. 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, <http://gomhydratejip.ucsd.edu/>, are used to point the reader to more detailed information concerning various aspects of the project. The discussion of the work performed during April 2009 – September 2009 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 based on 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 deepwater GOM using seismic, core and logging data. Phase III of the project is to collect data on hydrate bearing sands. Both logging and coring operations are planned.

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:

<http://gomhydratejip.ucsd.edu/>

2.1 *LWD Cruise*

The LWD cruise met or exceeded its scientific and management goals. The cruise was completed without a lost time injury, an environmental incident, and within budget.

The pre-cruise hydrate estimates were in agreement with the log data and high concentrations of hydrates were found in sand bodies.

The cruise proved that the methods employed by the JIP to locate and predict hydrates were accurate.

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2.2 *Workshop*

A workshop to present the LWD data and discuss equipment development and plans of 2010 program was held in Houston on the 19th and 20th of August..

2.3 *Pressure Corer*

Revised proposals for pressure coring and transfer equipment are being prepared..

2.4 *A new web site is in operation.*

The new web site will contain all of the digital records for the JIP. The URL for the site is <http://gomhydratejip.ucsd.edu/>.

3.0 Results and Discussion Phase II

3.1 *Task 1.0 – Research Management Plan*

Work on this task is complete and has been reported on in previous semi-annual reports.

3.2 Task 2.0 – Project Management and Oversight

Work on this task is complete and has been reported on in previous semi-annual reports.

3.3 Task 3.0 – Validation of New Gas Hydrate Sensors

Work on this task is complete and has been reported on in previous semi-annual reports.

3.4 Task 4.0 – Validation of the Well Bore Stability Model

Work on this task is complete and has been reported on in previous semi-annual reports.

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

Work on this task is complete and has been reported on in previous semi-annual reports.

3.6 Task 6.0 – Data Analysis – Initial Cruise

Work on this task is complete and has been reported on in previous semi-annual reports.

3.7 Task 7.0 – Technical Conference

Work on this task is complete and has been reported on in previous semi-annual reports.

3.8 Task 8.0 – Field Sampling Device Development

Work on this task is complete and has been reported on in previous semi-annual reports.

3.9 Task 9.0 – Recommendation for Further Activities

Work on this task is complete and has been reported on in previous semi-annual reports.

**4.0 Discussion and Results PHASE III A – Follow on Field Activities
Drilling and Logging**

Phase III activities consist of work focused on characterization and evaluation of hydrate occurrence within coarse-grained horizons within the Gulf of Mexico. The activities include preparation for these field activities through analyses and technology

development, carrying out of the field activities and post field activity analysis and reporting. Field sites included in the investigation will be selected upon mutual agreement of the Recipient and DOE with the intent of testing alternative models of gas hydrate occurrence. Planned activities associated with Phase III are outlined in the task/subtask descriptions to follow.

4.1 Task 1.0 – Research Management Plan

The research management plan was prepared and submitted to the DOE.

4.2 Task 2.0 – Project Management and Oversight

October 2007 through March 2008: The project manager appointed by the JIP members held weekly conference calls with the DOE project managers and provided other reports and presentations as required. See Appendix A for a summary of milestones and progress to date.

The JIP Executive Board (EB) approved two new members—the Korean National Oil Company and StatoilHydro—to become members of the JIP.

Members of the EB also attended the site selection drill operations meeting.

The JIP web site is being maintained and a new web site at Scripps is being evaluated.

The chief scientist for the LWD leg was selected and candidates for the coring leg evaluated.

Total DOE project funds are approximately 56% spent and total project funds are 99% spent or obligated for the remaining Phase III A estimated costs.

April 2008 through September 2008: The project manager appointed by the JIP members held weekly conference calls with the DOE project managers and provided other reports

and presentations as required. See Appendix A for a summary of milestones and progress to date.

The Korean National Oil Company and StatoilHydro became members of the JIP.

The JIP web site is being maintained and a new web site at Scripps is being designed.

Total DOE project funds are approximately 59% spent and total project funds are 92% spent or obligated for the remaining Phase III A estimated costs.

October 2008 through March 2009: The project manager appointed by the JIP members held weekly conference calls with the DOE project managers and provided other reports and presentations as required. See Appendix A for a summary of milestones and progress to date.

The new JIP Web site is on line and ready for the public.

Project status and goals were presented to the NRC committee evaluating the DOE program.

Total DOE project funds are approximately 59% spent and total project funds are 97% spent or obligated for the remaining Phase III A estimated costs.

April 2009 through September 2009: The project manager appointed by the JIP members held by-weekly conference calls with the DOE project managers and provided other reports and presentations as required. See Appendix A for a summary of milestones and progress to date.

The LWD cruise was conducted safely and within budget. A total of 7 holes were drilled in 3 OCS blocks.

Results of the LWD Cruise were presented in a workshop in Houston on 19 and 20 August. Approximately 60 people attended the 1 ½ day workshop.

After the workshop a meeting of the Hydrate JIP Members was held to discuss the recommendation from the workshop.

Total DOE project funds are approximately 76% spent and total project funds are 83% spent or obligated for the remaining Phase III A estimated costs.

4.3 Task 3.0 – Field Program – Drilling/Logging

October 2007 through March 2008: Several meetings were held in Houston between the LWD contractor (Schlumberger), Chevron drilling engineers, and the USGS Chief Scientist for the LWD leg. A design of the LWD tool string has been developed but may change before the cruise.

Safety training for the personnel on the LWD leg has been determined and will be arranged.

Locations for hazard analysis have been selected and hazard analysis will begin in April. See Appendix B for location maps of the holes.

A drill ship has been selected and drilling and logging is being planned for late June into July but could change because of drill ship schedule. In the worse case the ship schedule could slip into late 2008.

April 2008 through September 2008: A design of the LWD tool string has been developed that will allow for both tool strings to be used.

Safety training for the personnel on the LWD leg has been determined and conducted.

Locations for hazard analysis have been selected and hazard analysis completed.

The drill ship selected was unable to complete other work in time for this program to conduct drilling in the time we had contracted. The contract was revised and we are now planning on conducting LWD operations under the same terms in the first or second quarter of 2009.

October 2008 through March 2009:

All necessary cruise planning work was completed and permits filed with the required agencies. The estimated start date for the LWD leg is 16 April 2009 with a duration of approximately 21 days.

April 2009 through September 2009:

The LWD Leg was conducted safely and within budget. LWD holes were drilled in WR313, GC955, and AC 21 (see Table 4.3.1 for details). Hydrate concentrations were in agreement with the pre-cruise estimates for WR313 and GC955. A pre-cruise estimate was not available for AC21 because it was added late to the drilling plan.

Appendix B presents figures for the pre-cruise seismic estimates and the LWD logs for the 3 holes in GC 955 and 2 holes in WR 313. It is clear from the displays that pre-cruise estimates were in agreement with the log measurements.

Table 4.3.1 LWD Hole Locations and General Data

Hole	Latitude	Longitude	Water Depth (feet)	Water Depth RKB (ft)	Total Depth of Hole RKB (ft)	Total Depth of Hole Below Seafloor (ft)
AC 21 A	26°55' 25.0550"	94°54' 00.8545"	4889	4940	6700	1760
AC 21 B	26° 56' 40.3922"	94°53' 36.4053"	4883	4934	6050	1116
GC 955 H	27° 00' 03.2836"	90°25' 35.4475"	6670	6721	8654	1933
GC 955 I	27° 01' 00.7414"	90°25' 17.2257"	6770	6822	9027	2205
GC 955 Q	27° 00' 08.5611"	90°26' 12.0500"	6516	6567	8078	1511
WR 313 G	26° 39' 48.7355"	91°41' 02.3996"	6562	6614	10200	3586
WR 313 H	26° 39' 46.0997"	91°40' 34.2051"	6450	6501	9770	3269

4.4 Task 4.0 – Data Analysis

October 2007 through March 2008: No work accomplished this period.

April 2008 through September 2008: No work accomplished this period.

October 2008 through March 2009: No work accomplished this period.

April 2009 through September 2009:

The LWD data collected during the cruise was analyzed and sample logs are presented in Appendix B. Additional sonic data is expected in October and should be analyzed by year end. The log data was presented in the August workshop.

4.5 Task 5.0 – Improved Hydrate Recovery, Detection and Measurement Equipment

October 2007 through March 2008: No work accomplished this period.

April 2008 through September 2008: No work accomplished this period.

October 2008 through March 2009:

Proposals for the additional equipment needed to handle and transfer pressure cores on the ship were received and reviewed.

April 2009 through September 2009:

Pressure coring and transfer equipment proposal were reviewed and discussed at the August workshop. Revised proposals are expected in October.

4.6 Task 6.0 – Detailed Seismic Study of Selected Drilling Locations

October 2007 through March 2008:

3-D analysis of GC955 and WR313 is complete and a report from the site selection group is expected in May.

April 2008 through September 2008:

A draft of the final report for GC955 and WR 313 is complete and is expected in November 2008.

October 2008 through March 2009:

Final site selection reports received for GC955, GC781, GC825, and WR313. The report of GC955 is attached to this report as Appendix B the other site selection reports may be found on the JIP Web Site.

Site selections reports are being prepared for EB992 and AC21.

April 2009 through September 2009:

A contract for analysis of AC21 area is being prepared. A proposal for updating the seismic models based on log and core data was received and will be issued in Phase III B.

4.7 Task 7.0 – Well Bore Stability

October 2007 through March 2008: Analysis of the three sites (AC, GC, and WR) areas has been started and waiting on final well locations to be completed.

April 2008 through September 2008: Well bore stability analysis completed for AC and is progress for GC and WR. A final report is expected in November of 2009.

October 2008 through March 2009:

Well bore stability analysis, well maps, and pore pressure predictions completed and received for GC955, GC781, GC825, WR313, EB992, and AC21.

April 2009 through September 2009:

Well bore stability models are being updated based on the LWD data obtained.

4.8 Task 8.0 – Data on Lab Samples

October 2007 through March 2008: No work accomplished this period.

April 2008 through September 2008: No work accomplished this period.

October 2008 through March 2009: No work accomplished this period.

April 2009 through September 2009: No work accomplished this period.

5.0 PHASE III B – FOLLOW ON FIELD ACTIVITIES (CORING) AND FINAL REPORTING

Phase III B activities are to include work focused on characterization and evaluation of hydrate occurrence within coarse grained horizons within the Gulf of Mexico. The activities include preparation for these field activities through analyses and technology development, carrying out of the field activities and post field activity analysis and reporting. Field sites to be included in the investigation will be selected upon mutual agreement of the Recipient and DOE with the intent of testing alternative models of gas hydrate occurrence. Planned activities associated with Phase III B are outlined in the task/subtask descriptions to follow.

5.1 Task 1.0 – Revised Research Management Plan

October 2007 through March 2008: No work accomplished this period.

April 2008 through September 2008: No work accomplished this period.

October 2008 through March 2009: No work accomplished this period.

April 2009 through September 2009: No work accomplished this period.

5.2 Task 2.0 – Project Management and Oversight

October 2007 through March 2008: No work accomplished this period.

April 2008 through September 2008: No work accomplished this period.

October 2008 through March 2009: No work accomplished this period.

April 2009 through September 2009: No work accomplished this period.

5.3 Task 3.0 – Field Program – Coring

October 2007 through March 2008: No work accomplished this period.

April 2008 through September 2008: No work accomplished this period.

October 2008 through March 2009: No work accomplished this period.

April 2009 through September 2009: No work accomplished this period. No work accomplished this period.

5.4 Task 4.0 – Data Analysis

October 2007 through March 2008: No work accomplished this period.

April 2008 through September 2008: No work accomplished this period.

October 2008 through March 2009: No work accomplished this period.

April 2009 through September 2009: No work accomplished this period. No work accomplished this period.

5.5 Task 5.0 – Improved Hydrate Recovery, Detection and Measurement Equipment

October 2007 through March 2008: No work accomplished this period.

April 2008 through September 2008: No work accomplished this period.

October 2008 through March 2009: No work accomplished this period.

April 2009 through September 2009: No work accomplished this period. No work accomplished this period.

5.6 Task 6.0 – Detailed Seismic Study of Selected Drilling Locations

October 2007 through March 2008: No work accomplished this period.

April 2008 through September 2008: No work accomplished this period.

October 2008 through March 2009: No work accomplished this period.

April 2009 through September 2009: No work accomplished this period. No work accomplished this period.

5.7 Task 7.0 – Well Bore Stability

October 2007 through March 2008: No work accomplished this period.

April 2008 through September 2008: No work accomplished this period.

October 2008 through March 2009: No work accomplished this period.

April 2009 through September 2009: No work accomplished this period.

5.8 Task 8.0 – Data on Lab Samples

October 2007 through March 2008: No work accomplished this period.

April 2008 through September 2008: No work accomplished this period.

October 2008 through March 2009: No work accomplished this period.

April 2009 through September 2009: No work accomplished this period. No work accomplished this period.

5.9 Task 9.0 – Technical Conference and Compilation of Scientific Papers

October 2007 through March 2008: No work accomplished this period.

April 2008 through September 2008: No work accomplished this period.

October 2008 through March 2009: No work accomplished this period.

April 2009 through September 2009: No work accomplished this period. No work accomplished this period.

6.0 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.

7.0 Conclusions

The LWD cruise met or exceeded its scientific and management goals. The cruise was completed without a lost time injury, an environmental incident, and within budget.

The pre-cruise hydrate estimates were in agreement with the log data and high concentrations of hydrates were found in sand bodies.

The cruise proved that the methods employed by the JIP to locate and predict hydrates were accurate.

8.0 References

No external references were used for this report.

9.0 Appendix A, B

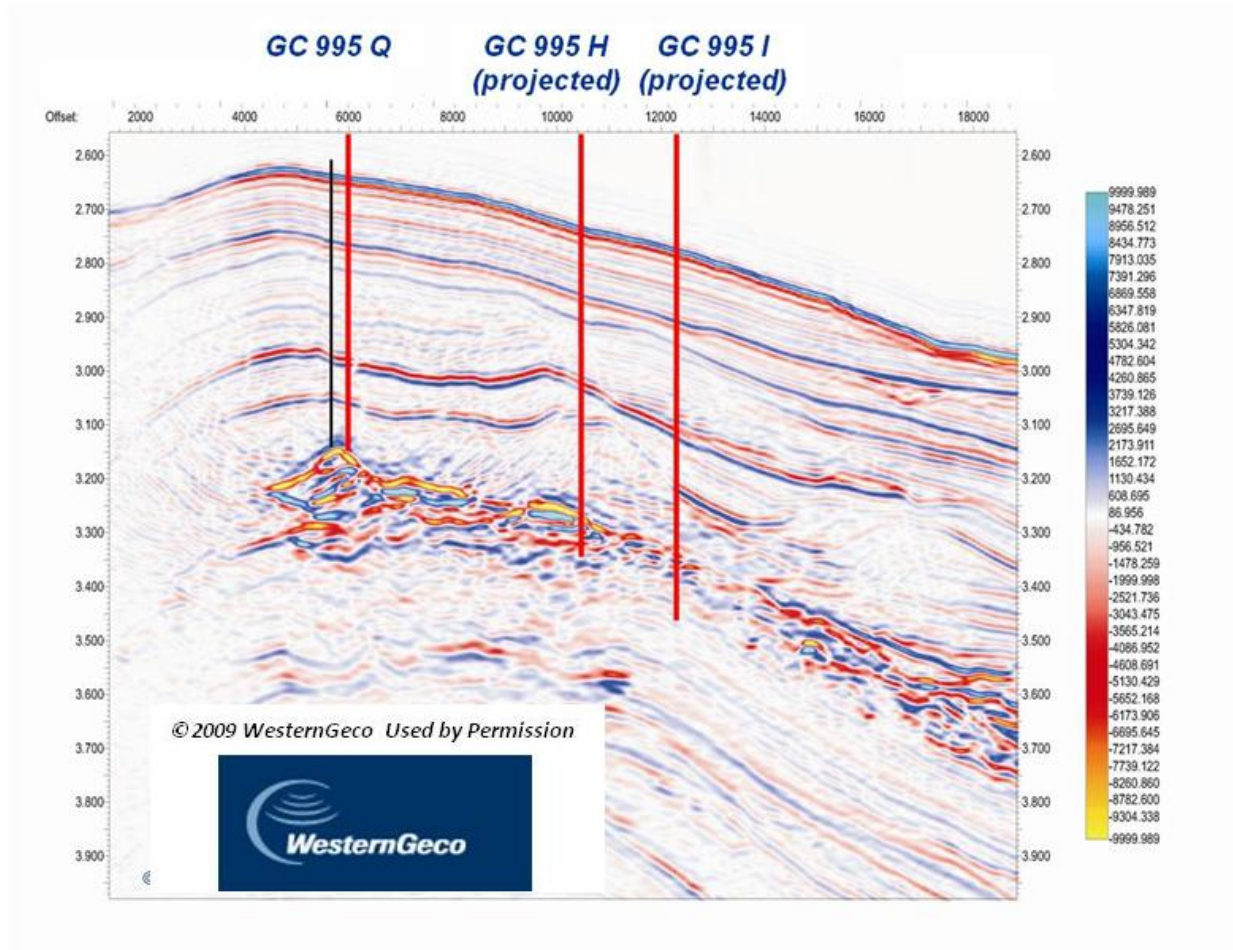
APPENDIX A

Milestone Table A1

#	Milestone	Plan date	Progress	Comments
1	Select LWD Locations	Q2 08	Complete. Another block may be selected in October.	Site selection report for GC955 and WR313 is expected in May and will be included in the next semi-annual report. AC818 report was included in Semi-Annual Report 41330R13. An additional location for LWD drilling may be selected in October of 2008 as an alternate to AC818.
2	Complete Design of Pressure Coring Equipment	Q2 08	Design work complete; final report is expected in October.	Final report received.
3	LWD Selected Locations	Q3 08	LWD locations were selected.	LWD Cruise was completed in Q2 09.
4	Report on LWD Phase III A Task 3 Deliverable	Q4 08	LWD drilling was delayed until March 2009 due to drill ship schedule.	LWD results presented in a workshop in August 09. Several papers and presentations are planned for the fall of 2009.
5	Complete Research Management Plan	Q1 09	Complete	Complete
6	DOE Approval to Proceed to Phase III B	Q2 09	Complete	
7	Complete Construction of New Pressure Coring Equipment	Q3 09	Behind schedule	A revised cost estimate was required for both the pressure coring equipment and the transfer equipment.
8	Field Test Pressure Coring Equipment	Q4 09		This currently being planned for Q1 2010
9	Select Sites for Coring Leg	Q4 09		This will be completed in Q1 10.
10	Conduct a Hazard Analysis of Sites and Apply for Permits	Q2 10		
11	Core Selected Locations	Q3 10		
12	Report on Lab and Coring Data	Q4 10		
13	Final Report	Q4 10		

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APENDIX B



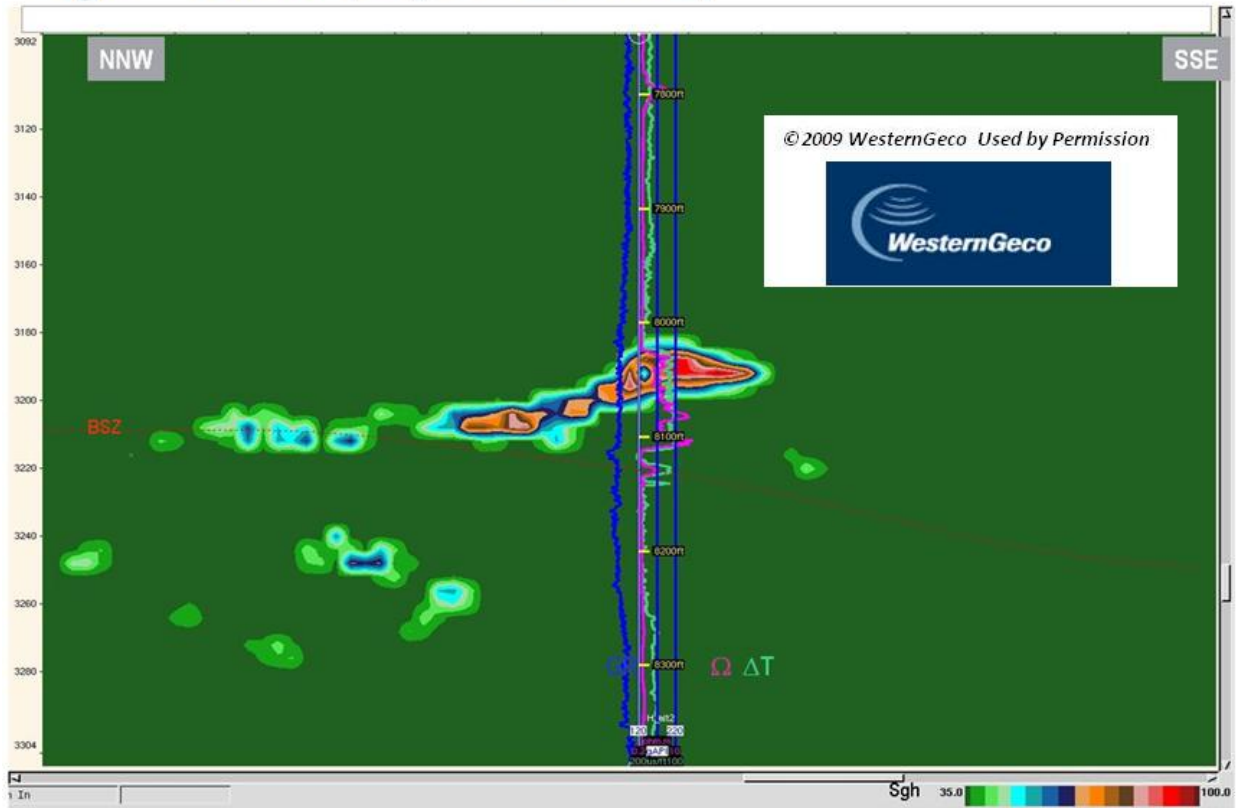
GC 955 Seismic Amplitude showing location of the 3 holes and seismic indication of hydrates.

Random Line - Sgh (using shale-sand model)



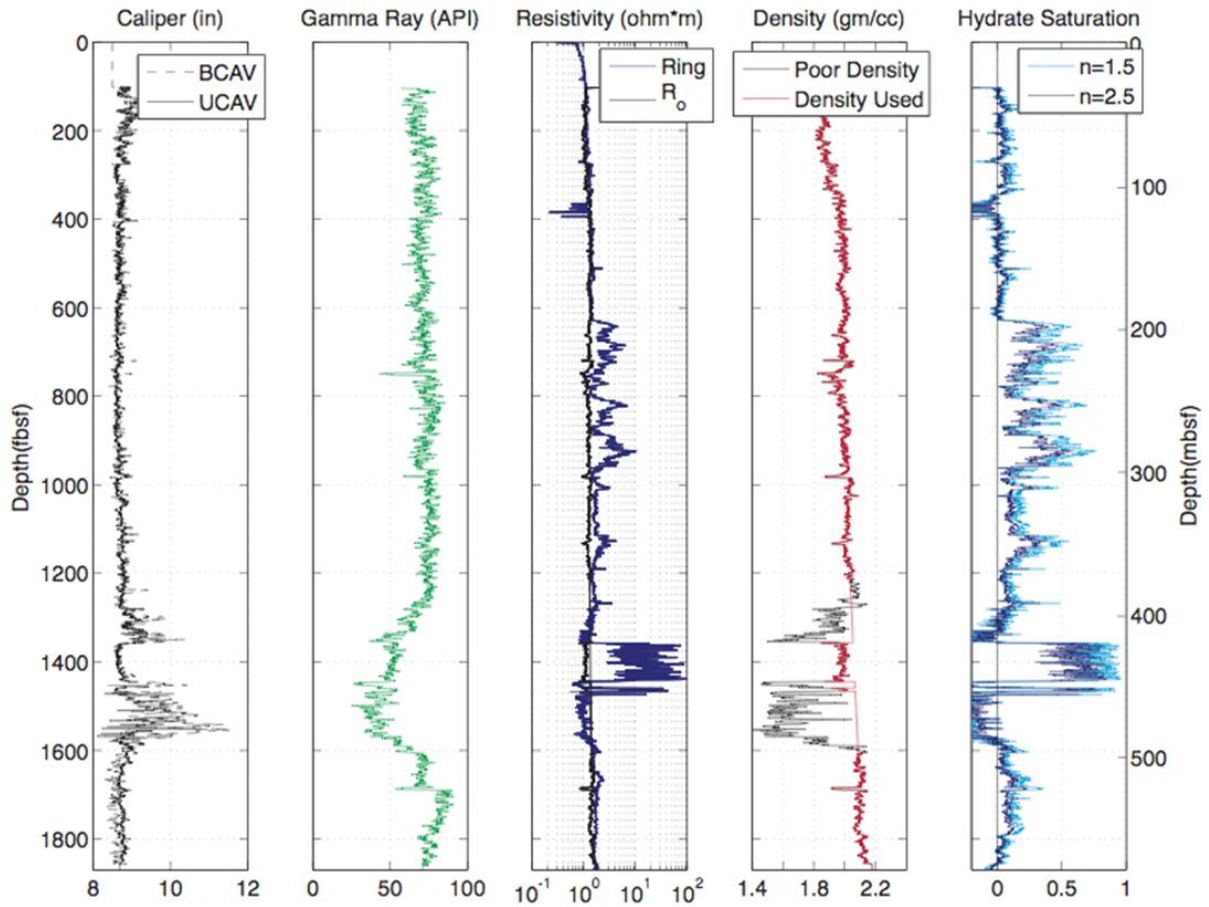
GC 955 Pre-cruise hydrate prediction with 3 well logs

Sgh – well H (using shale-sand model)



GC 955 Pre-cruise hydrates prediction for target area of the H hole.

GC955-H



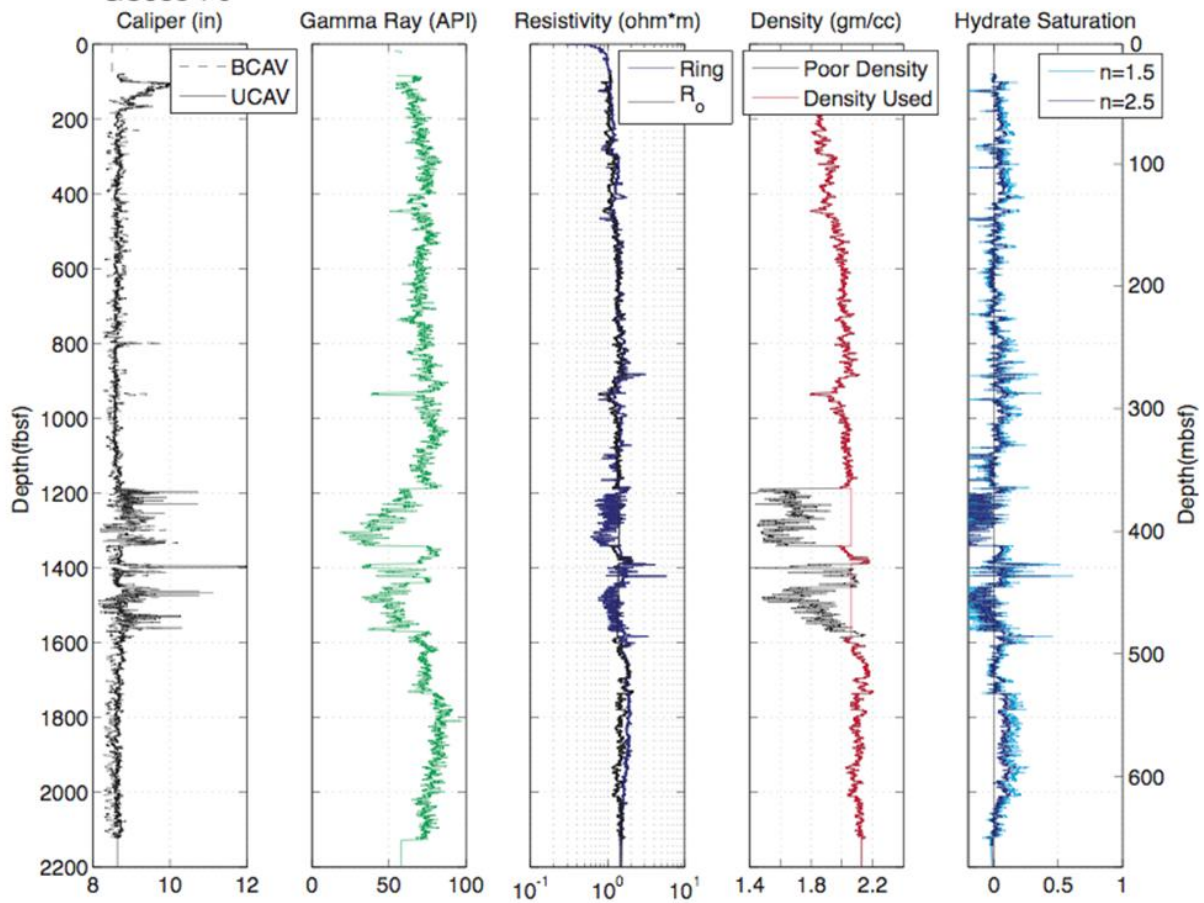
GC 955 LWD logs for H hole. Logs indicate about the same location and concentration of hydrates as the pre-cruise estimate.

Sgh – well I (using shale-sand model)



GC 955 Pre-cruise hydrate prediction for target area of the I hole.

GC955-I



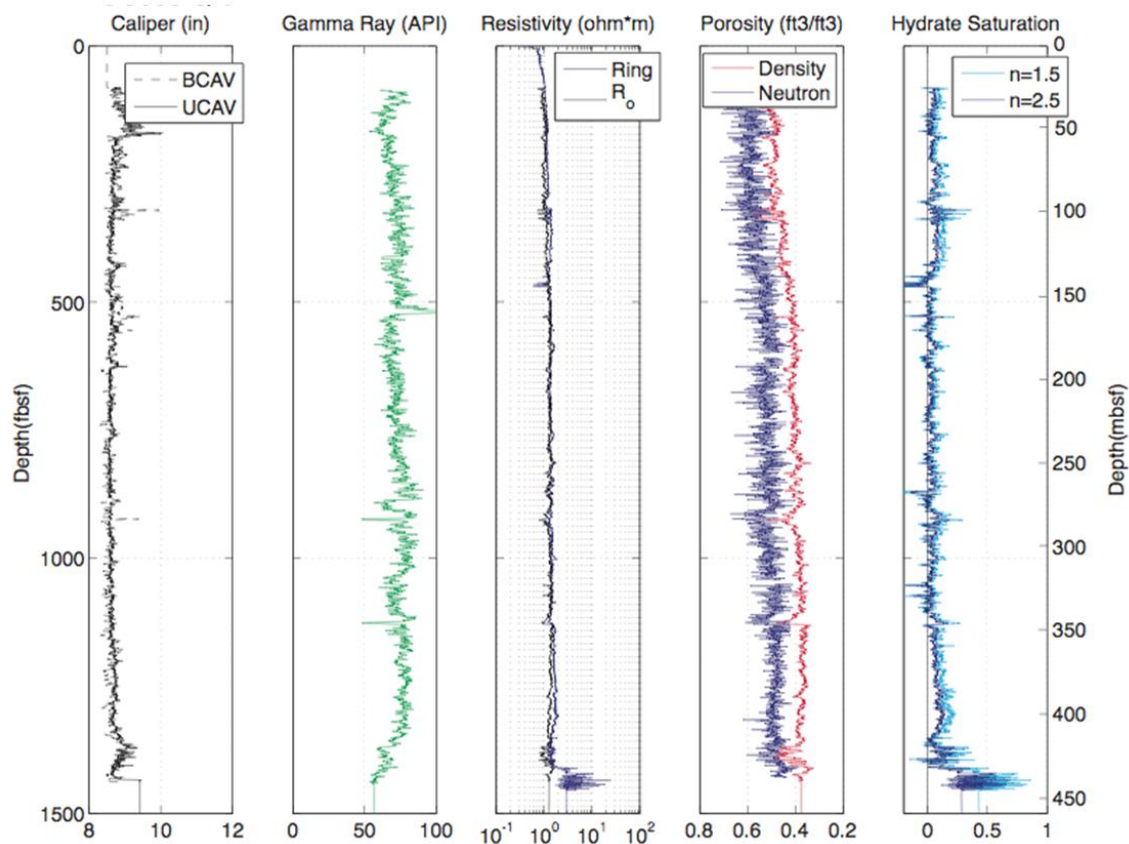
GC 955 LWD logs for I hole. Logs indicate about the same location and concentration of hydrates as the pre-cruise estimate.

Sgh – well Q (using shale-sand model)



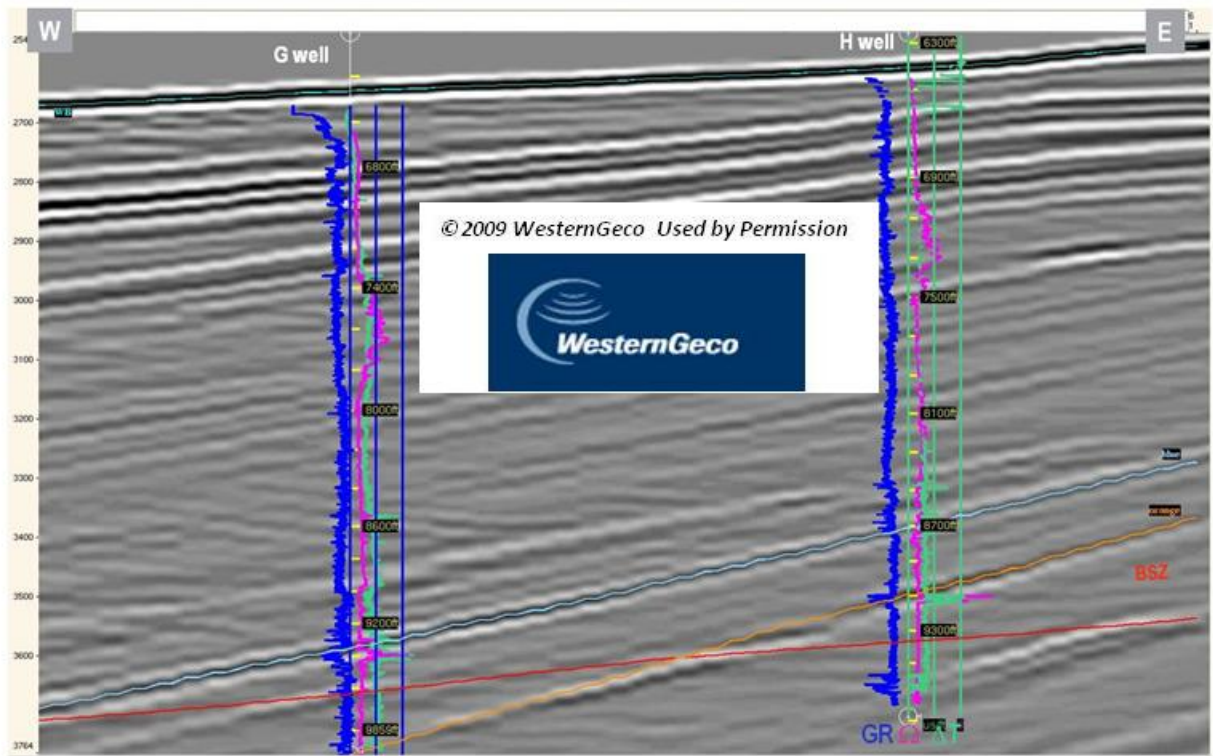
GC 955 Pre-cruise hydrates prediction for target area of the Q hole.

GC955-Q



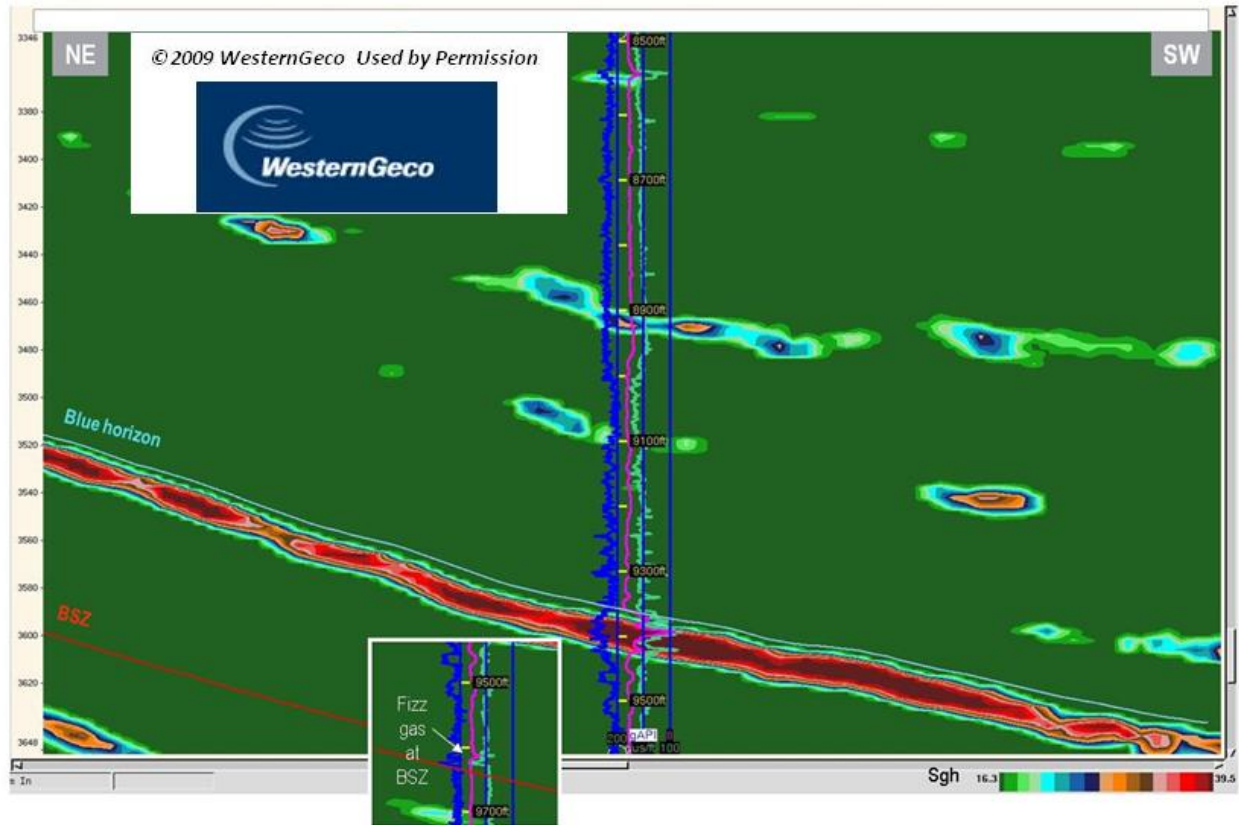
GC 955 LWD logs for Q hole. Logs indicate about the same location and concentration of hydrates as the pre-cruise estimate.

Random PSTM Seismic Line



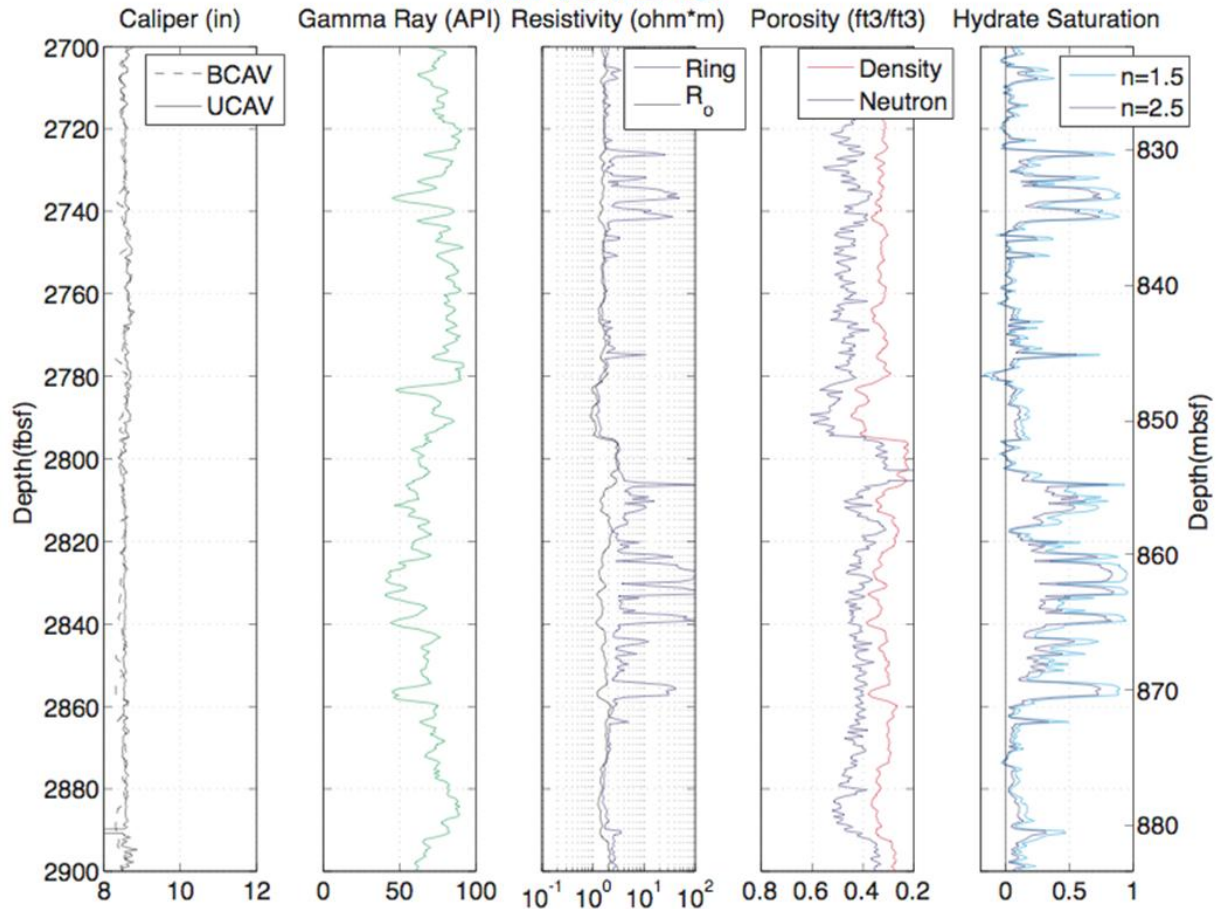
WR 313 Seismic Amplitude showing location of the 2 holes and seismic indication of hydrates.

Sgh – well G (using shale-sand model)



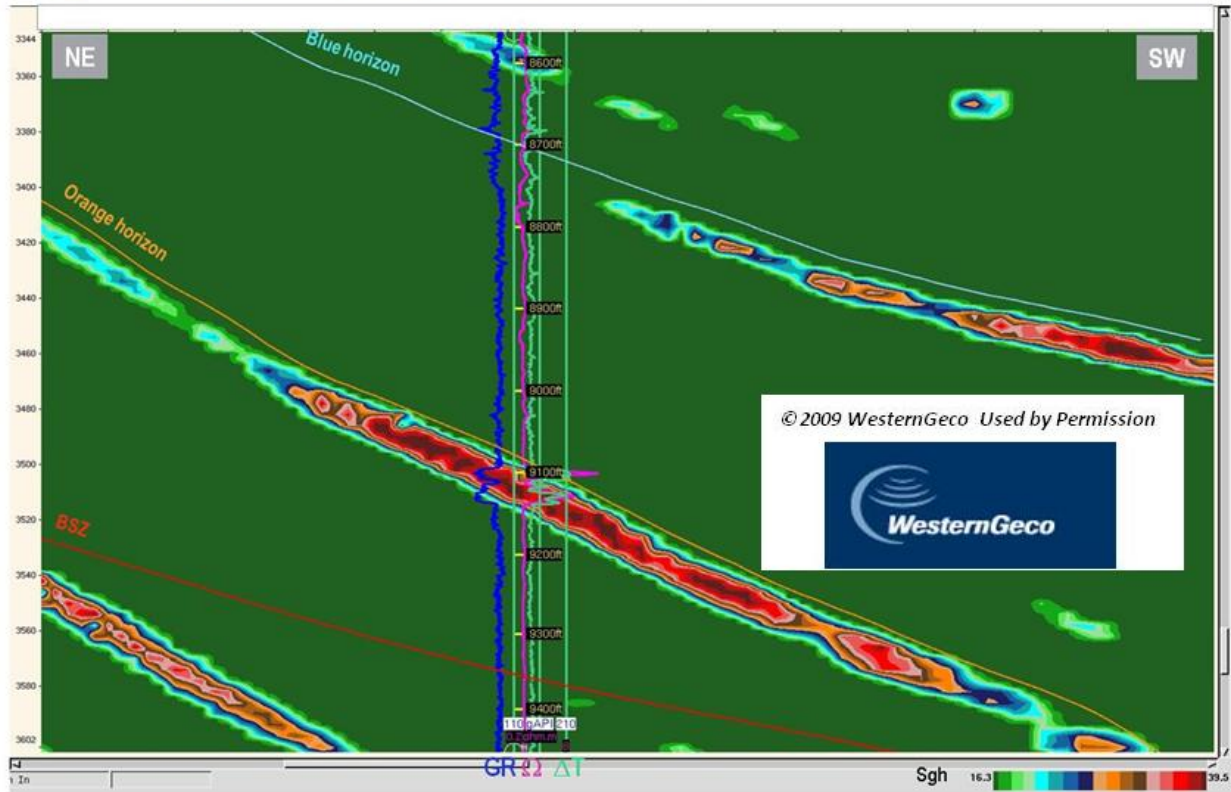
WR 313 Pre-cruise hydrates prediction for target area of the G hole.

WR313-G

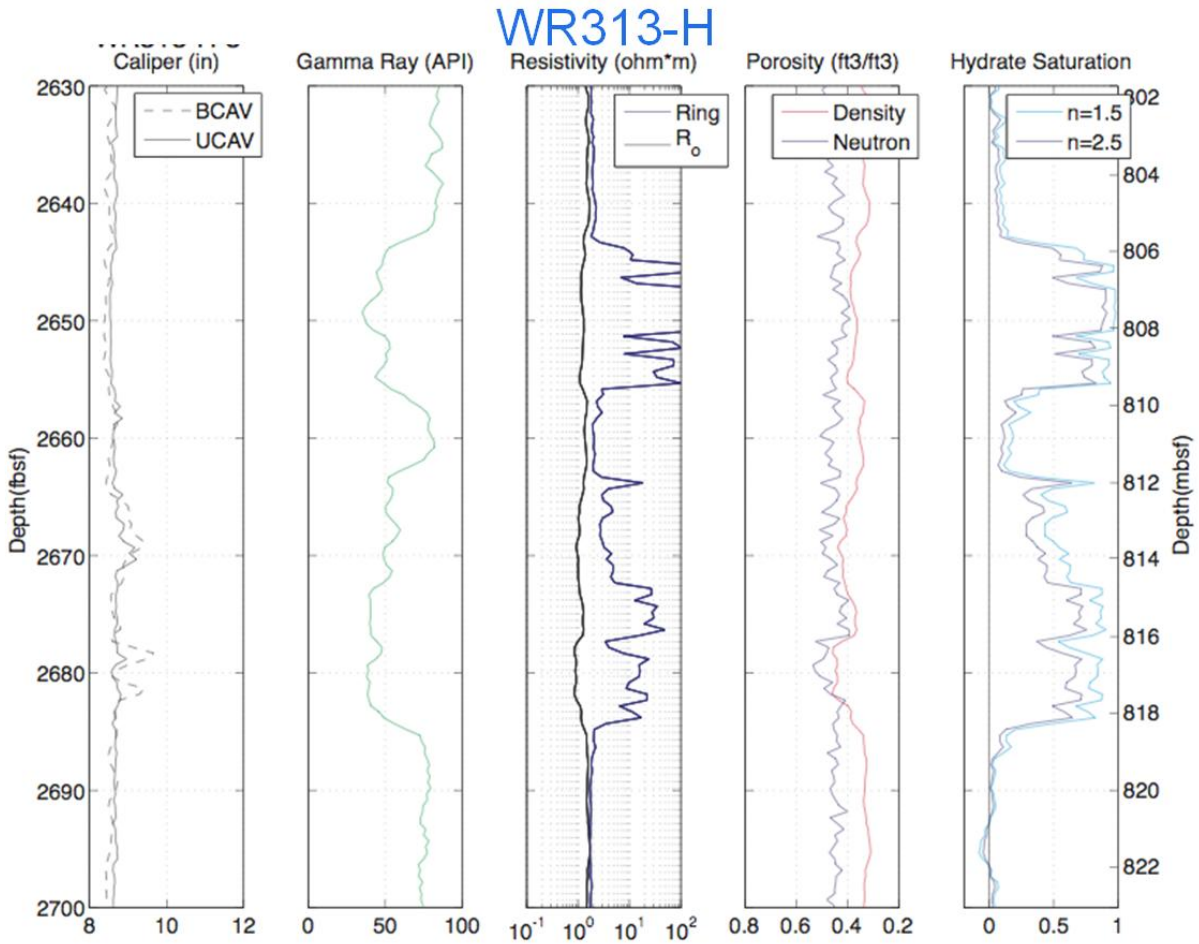


WR 313 LWD logs for G hole. Logs indicate about the same location and concentration of hydrates as the pre-cruise estimate.

Sgh – well H (using shale-sand model)



WR 313 Pre-cruise hydrates prediction for target area of the H hole.



WR 313 LWD logs for H hole. Logs indicate about the same location and concentration of hydrates as the pre-cruise estimate.

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