Oil & Natural Gas Technology

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Quarterly Research Performance Progress Report (Period ending 9/30/2014)

A new approach to understanding the occurrence and volume of natural gas hydrate in the northern Gulf of Mexico using petroleum industry well logs

10/1/2012-9/30/2015

Submitted by:
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EXECUTIVE SUMMARY

The main objective of the project is to significantly increase our understanding of the occurrence, volume and fine scale distribution of natural gas hydrate in the northern Gulf of Mexico using petroleum industry and Gulf of Mexico Gas Hydrate Joint Industry Project (JIP) well logs.

First Year

In the first quarter (October 1, 2012-December 13, 2012), the initial steps were to establish an estimate for the base of gas hydrate stability zone (GHSZ) for each industry well in the Gulf of Mexico and begin ordering industry well data. For the modeling side of the project, student Brian Tost completed a formation model for JIP2 wells in Alaminos Canyon, Gulf of Mexico. Ann Cook and Barbara Anderson began constructing formation models for the sand reservoir in Green Canyon, Gulf of Mexico.

In the second quarter (January 1, 2013-March 31, 2013) well orders were completed for each block in the Gulf of Mexico, by Cook, Urmi Majumdar (PhD student), Abby Crock (undergraduate hourly) and Samyra Ismail (undergraduate hourly). Eleven total DVDs were ordered from the Bureau of Safety and Environment Enforcement (BSEE). Student Brian Tost defended his master's thesis on the JIP Alaminos Canyon wells. Undergraduate senior Abby Crock completed her thesis on Alaminos Canyon industry wells in Block 857.

In the third quarter (April 1, 2013 – June 30, 2013) Urmi Majumdar and Samyra Ismail began working on well assessments by Gulf of Mexico Block. This involved opening each well log, noting the types of logs available in the GHSZ and analyzing the log for any signs of natural gas hydrate By the end of June, Majumdar completed initial reports on all of the wells in East Breaks and Keathley Canyon. The plan is to produce reports of this type for all assessed Gulf of Mexico Blocks. At the end of May, Tost and Cook submitted a conference article entitled, 'Do Gas Hydrates Occur in Alaminos Canyon, Gulf of Mexico?' the Unconventional Resources Technology Conference, which will be presented in August 2013. Tost was moved to a part time hourly worker for the summer (June 1-August 16) so he can complete the manuscript on Alaminos Canyon for the Journal of Geophysical Research. Cook and Anderson worked on resistivity formation models for JIP2 Hole GC955-H. Unfortunately, some of the Schlumberger proprietary models have changed and do not match the well conditions in Hole GC955-H. Anderson is working on having Schlumberger reinstate the old models.

In the fourth quarter (July 1 – September 30, 2013) Majumdar continued working on assessments in the Gulf of Mexico, specifically focusing on Alaminos Canyon and Mississippi Canyon. The report for Alaminos Canyon can be found on pages 7-13 of this quarterly report. Tost presented his work at the Unconvetional Resources technology conference. Tost and Cook continued to work on to work on the Alaminos Canyon Block 21 manuscript for submission to JGR. Anderson was able to fix the Schlumberger proprietary models, but we were not able to complete the resistivity formation models for GC955-H and WR313-G because of the delay.

The target completion date for the resistivity models was moved to December 31, 2013.

Second Year

In the first quarter of year two (October 1, 2013-December 31, 2013), Majumdar and Cook continued working on the Gulf of Mexico assessments. Over half of the large protraction areas have now been completed (see Figures 1 & 2); including East Breaks, Alaminos Canyon, Keathley Canyon and Garden Banks. The northern section of Mississippi Canyon has also been completed. Majumdar and Cook submitted abstracts to ICGH and the GRC. The ICGH abstract was accepted with an Oral presentation. Cook and Tost submitted the manuscript on Alaminos Canyon to JGR. In December, Cook and Majumdar held a phone conference with Matt Frye and Bill Shedd and discussed several of the prospects in mid-December.

In course of the second quarter of year two (January 1, 2014 – March 31, 2014), initial assessments for Garden Banks, Green Canyon, Walker Ridge, Atwater Valley and Mississippi Canyon. These wells will be double-checked before digital well data is ordered. Ismail compiled maps from the Year 2, Q1 assements in addition to Garden Banks. In February, Cook and Majumdar presented a summary of the project and a request for project continuation to DOE, which was granted. In March, Cook, Majumdar and Ismail presented three posters on this project at the Gordon Research Seminar. Additionally, Majumdar presented a talk at the Gordon Research Seminar the weekend before the GRC.

Resistivity models for GC 955 and WR 313 are still behind. Cook has identified new models that may be used instead of Schlumberger's proprietary models and will be pursuing these in May.

During the third quarter of the second year (April 1, 2014- June 30, 2014), two additional undergraduate students were hired (Andrew Burchwell and Mackenzie Scharenberg) to double check all of the logs and spreadsheets for hydrate prospects in the Gulf of Mexico. In addition, we changed some of the criteria and the new students worked with Majumdar to update and correct any spreadsheet errors. We developed new criteria to rank each of the reservoirs:

Reservoir I: Resistivity > 5 ohm-m from established background
Reservoir thicker than 30 ft
Reservoir II: Reservoir meets only 1 of the conditions from Reservoir 1
Reservoir III: Resistivity greater than 0.5 ohm-m above background

Also during the third quarter, we calculated hydrate saturation in fracture accumulations in WR313 and GC955H using best-fit ANISBED models. Saturations ranged from ~2% to 20% in the fractured accumulations. Cook is looking into additional modeling methods to help constrain these estimates. Majumdar submitted a conference paper to ICGH on the project. Cook published a paper in the JMPG special issue on India including some of her work on GC955 and WR313 on the project.

In the fourth quarter of year two, July 1 – September 30, 2014, further refinement of reservoir rankings was established:

Reservoir 1: 5 ohm*m or above increase in resistivity above background for at least 30 ft.

Reservoir 2 :

2A – 2ohm.m or more (<5ohm.m) increase in resistivity above background and for at least 30 feet.

2B – 0.5 to 2 ohm.m increase in resistivity above background for at least 30 ft OR >5 ohm.m increase above background resistivity but < 30 feet.

Reservoir 3 – 0.5 to 2 ohm.m increase above background resistivity for < 30 feet.

With these new rankings, we hope to clearly convey the best reservoirs clearly to anyone interested in the data. When available during the summer, undergradute students Sharenberg, Burchwell and Ismail continued to double check the results from the first round of well log assessments, fixed clerical errors and clarified sections of the spreadsheets. Majumdar presented the current results of the project at the International Conference on Gas Hydrates in Beijing, China.

PROGRESS, RESULTS AND DISCUSSION

See Table 1 for Project Timeline on each task and subtask.

Task 1.0 – Project Management Plan

During October and November, the Cook worked with Skip Pratt to develop the PMP for the project. It was completed on November 27, 2012.

Cook participated in a project kickoff conference call with DOE on November 7, 2012.

Task 2.0: Evaluation of gas hydrate occurrence in petroleum industry well logs

Subtask 2.1: **Calculate the depth of the GHSZ depth in the Gulf of Mexico using ArcGIS.**

Gas hydrate stability zone models for the Gulf of Mexico were received from Matt Frye, BOEM. These models contain minimum, mean and maximum estimates as well as breakdowns from P10-P90. The Frye models were assessed and by Cook and students, and compared to a blanket GIS calculation based only on bathymetric depth. We decided Frye models were likely more accurate, and decided to use the P90 gas hydrate stability zone depth as a cutoff for the log order. Thus, wells that contains only logs depths deeper than P90 will not be ordered.

Students Tost and Ismail worked on outputting spreadsheet data from the GIS to make the industry well log orders. Some GIS issues, including missing wells, were encountered and hopefully fixed.

The first well data order from BSEE was on December 7, 2012 and ordering continued through he end of Q2. Two undergraduate students, Crock and Ismail, PhD student Majumdar, and Cook ordered well data and compiled spreadsheets on each well (Subtask 2.2). In total, 11 DVDs were ordered full of logging data from the Gulf of Mexico. This task was completed at the end of Q2.

Subtask 2.2: **Well log evaluation and database development.**

Spreadsheets were developed for each block in the Gulf of Mexico for wells drilled in water column greater than 1400 ft. Orders were then compiled on the BSEE website using their well query system. Each well was queried using the API number. The BSEE seafloor depth at each well was crosschecked with GIS bathymetry data to make sure hydrate stability zone calculations were reasonably valid. Well logs that were above the P90 cutoff were ordered in each well, including (but not limited to) gamma ray, resistivity, velocity, density, neutron porosity and caliper. Most frequently, wells only contained resistivity and gamma ray logs. Additionally, we will not know how shallow some of the logs were recorded until the log data is analyzed. Typically the top of logged interval is only reported for the top of any log and typically does not represent the top of logged interval for all logs.

Each well that was ordered will be analyzed completely through the Mean GHSZ estimate and anything of interest was noted through the P90 GHSZ estimate. We note year of logging and operator for each well. Logs available through the Mean GHSZ are noted, as well as mud type in the Mean GHSZ, and any well deviation in the GHSZ. Initial well assessment spreadsheets and reports were completed for East Breaks and Keathley Canyon in Q3, and Alaminos Canyon in Q4. Green Canyon was completed in January 2014. Initial assessments of all protraction areas were completed by the end of Year 2, Q2. Currently, we are in the process of double-checking the initial assessments before ordering data.

Task 3.0: Modeling of resistivity measurements from JIP Leg 2

Subtask 3.1: **Develop true resistivity models for sand reservoirs for JIP Leg 2 Holes**

A resistivity model that incorporates the measured resistivity and the seismic trace in for JIP2 Holes AC-21A and AC-21B has been developed by Tost and Cook.

The completion date for the resistivity models was moved until March, 2015, because Barbara Anderson lost access to the models needed to develop these models. Cook will use a new model available through Carlos Torres Verdin at UT Austin.

Subtask 3.2: **Determine hydrate saturation using best-fit ANISBED models.**

This task was completed on time. Currently Cook is looking into additional models to validate the estimates obtained.

Task 4.0: Determining volume of methane in gas hydrate in the northern Gulf of Mexico

Subtask 4.1: **Calculate hydrate saturation curves for Gulf of Mexico Industry wells where gas hydrate occurs in sand reservoirs.**

Gas hydrate saturation in sands are being calculated using Archie's quick look equation and a range of saturation exponents from 1.5-2.5. This task is on target for completion.

Subtask 4.2**: Additional ANISBED modeling in holes with gas hydrate in clay sediment that have unique background resistivity or very high resistivity accumulations.**

This subtask is complete. Two additional ANISBED models were run during Q1 of year 2.

Subtask 4.3**: Estimate methane volume at STP in Gulf of Mexico gas hydrates using Monte Carlo models**

This subtask will begin soon.

Task 5.0: Publication, presentation and dissemination of results.

- A conference paper was submitted for the Unconventional Resources Technology Conference, 'Do Gas Hydrates Occur in Alaminos Canyon, Gulf of Mexico?' with authors Tost and Cook. Tost presented this work in August 2013.
- Cook, Ismail and Majumdar attended the gas hydrate GRC and presented results from the project.
- The ICGH conference abstract was accepted with oral presentation. Majumdar traveld to Beijing to present this work.
- Cook published an article along with Dave Goldberg and Alberto Malinverno in a JMPG Special Issue on Gas Hydrates India, 'Natural gas hydrates occupying fractures: A focus on non-vent sites on the Indian continental margin and the northern Gulf of Mexico' that includes some work on this project for the hydrate reservoirs in WR313 and GC955H.
- A Fire and Ice article was submitted and published on the project, 'Gas Hydrate Assessment in the Northern Gulf of Mexico: Preliminary Results Reveal New Prospects' with Majumdar as lead author.
- A paper on the gas hydrate prospect in Alaminos Canyon was published in JGR by authors Cook and Tost.
- Majumdar and Cook will present additional results with coauthors Matt Frye and Bill Shedd at the Fall 2014 AGU conference.

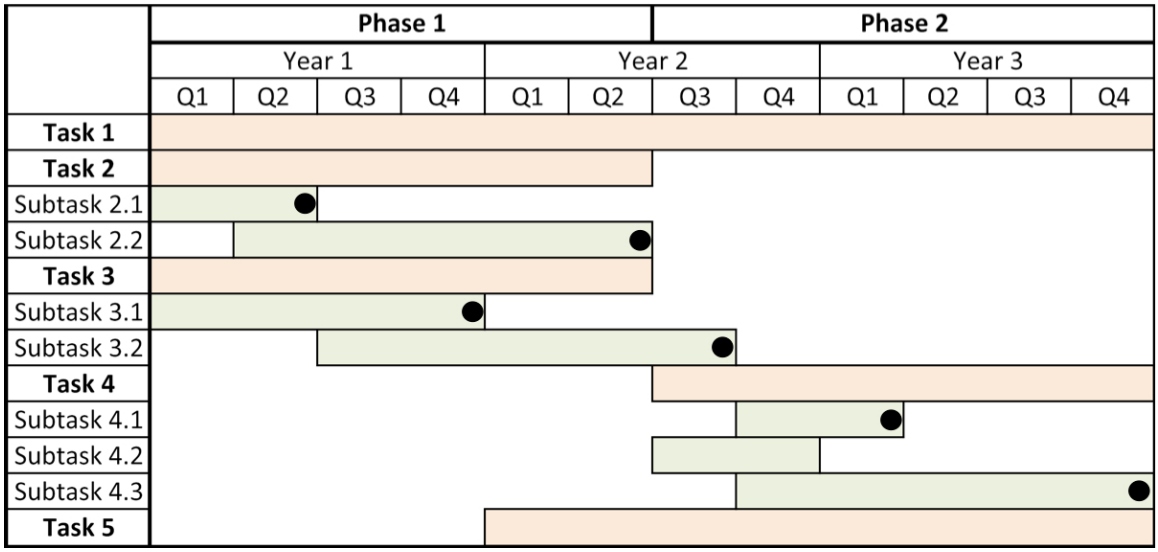

Table 1. Project timeline by task (tan bars) and subtask (green bars). Total project time is 2, 18 month-long phases (3 years). Milestones are indicated by a black dot.

PARTICIPANTS

Name: Ann Cook
Project Role: PI
Contribution: Managing student time, editing manuscripts, modeling hydrate saturations.
Person Months: 1

Name: Urmi Majumdar
Project Roll: Graduate student
Contribution: Writing and submitting papers, double-checking hydrate assessments.
Person Months: 3

Name (s): Sam Ismail, Andrew Burchwell, Mackenzie Scharenberg
Project Roll: Undergraduate hourly
Contribution: Mapping results of assessments. Double-checking spreadsheets and log analysis.

COSTS

During this quarter, charges to the project include graduate student tuition and stipend as well as hourly pay for undergraduates. Some travel from the previous quarter appears on these cost statements.

Department: **06560**
Principal Investigator: **Cook,Ann Elizabeth**
Sponsored Program Officer: **Port,Jared Austin**
Facilities & Administration Rate: **52.50 %**

The Ohio State University - Office of Sponsored Programs
Project Financial Summary
For the Month Ending: **SEP 30, 2014**
Project Period: ***10/01/2012*** to ***09/30/2015***

Project: **60036410**
Award: **GRT00028365**
Sponsor: **US Department of Energy**
Grant/Contract: **DE-FE0009949**

Project/Award Title: **New approach to understanding the occurrence and volume of natural gas hydrate in the northern Gulf of Mexico using petroleum industry well logs**

	Sponsor				
Category	**Budget**	**Expenses This Month**	**Expenses To Date**	**Commitments**	**Balance**
Salaries and Wages	106,854.00	2,263.82	62,180.74	13,615.74	31,057.52
Fringe Benefits	12,094.00	265.22	8,190.75	1,470.49	2,432.76
GA Tuition and Fees	48,391.00	0.00	19,257.00	17,225.00	11,909.00
Total Personnel Costs	167,339.00	2,529.04	89,628.49	32,311.23	45,399.28
Other Direct Costs	2,000.00	0.00	0.00	0.00	2,000.00
Materials and Supplies	0.00	0.00	1,181.00	0.00	-1,181.00
Domestic Travel	20,000.00	366.54	9,738.26	0.00	10,261.74
Foreign Travel	0.00	-1,022.06	1,233.86	0.00	-1,233.86
Purchased Services	15,000.00	0.00	0.00	0.00	15,000.00
Total Direct Costs	204,339.00	1,873.52	101,781.61	32,311.23	70,246.16
Facilities and Administrative	81,873.00	983.59	43,325.49	96.29	38,451.22
Total	**286,212.00**	**2,857.11**	**145,107.10**	**32,407.52**	**108,697.38**

	Cost Share				
Category	**Budget**	**Expenses This Month**	**Expenses To Date**	**Commitments**	**Balance**
GA Tuition and Fees	0.00	0.00	28,506.00	0.00	-28,506.00
Total Personnel Costs	0.00	0.00	28,506.00	0.00	-28,506.00
Total Direct Costs	0.00	0.00	28,506.00	0.00	-28,506.00
Facilities and Administrative	0.00	28.10	707.55	0.00	-707.55
Total	**0.00**	**28.10**	**29,213.55**	**0.00**	**-29,213.55**

	Third Party				
Category	**Budget**	**Expenses This Month**	**Expenses To Date**	**Commitments**	**Balance**
Other Direct Costs	22,500.00	0.00	0.00	0.00	22,500.00
Purchased Services	52,000.00	0.00	30,030.00	0.00	21,970.00
Total Direct Costs	74,500.00	0.00	30,030.00	0.00	44,470.00
Total	**74,500.00**	**0.00**	**30,030.00**	**0.00**	**44,470.00**

Table 2. Total costs through Year 2, Quarter 4.

Department: **06560**
Principal Investigator: **Cook,Ann Elizabeth**
Sponsored Program Officer: **Port,Jared Austin**

The Ohio State University - Office of Sponsored Programs
Detail of Expenses
For the Month Ending: **SEP 30, 2014**
Project Period: **10/01/2012** to **09/30/2015**

Project: **60036410**
Award: **GRT00028365**
Sponsor: **US Department of Energy**
Grant/Contract: **DE-FE0009949**

Project/Award Title: **New approach to understanding the occurrence and volume of natural gas hydrate in the northern Gulf of Mexico using petroleum industry well logs**

Account	**Account Description**	**Sponsor Expense**
60092	Graduate Research Associate	1,827.22
60131	Student (non-GA/non-FWSP)	96.80
60135	Under Enrolled/Non Fee Pd Stdt	339.80
	Salaries and Wages	2,263.82
60292	Bnft-Graduate Research Assoc	197.34
60331	Bnft-Student (non-GA/non-FWSP)	10.45
60335	Bnft-Under Enrl/NonFee Pd Stdt	57.43
	Fringe Benefits	265.22
	Total Personnel Costs	2,529.04
63405	Out of State - Univ Employee	366.54

Journal ID	Purchase Order	Voucher ID	Invoice ID	Vendor	Transaction Description	
AP03657564		15YYPFTL	21220T326807	TRAVEL SOLUTIONS	AIR T000326807 COOK	$366.54

	Domestic Travel	366.54
63409	Foreign Travel - Student	-1,022.06

Journal ID	Purchase Order	Voucher ID	Invoice ID	Vendor	Transaction Description	
0003645799				MAJUMDAR		($1,022.06)

	Foreign Travel	-1,022.06
	Total Direct Costs	1,873.52
66701	Indirect Costs	983.59
	Facilities and Administrative	983.59
	Total F&A Costs	983.59
	Total Project Costs This Month	**2,857.11**

Account	**Account Description**	**Cost Share Expense**
66701	Indirect Costs	28.10
	Facilities and Administrative	28.10
	Total F&A Costs	28.10
	Total Project Costs This Month	**28.10**

Table 3. Detail of expenses Year 2, Quarter 4.

Department: **06560**
Principal Investigator: **Cook,Ann Elizabeth**
Sponsored Program Officer: **Port,Jared Austin**

The Ohio State University - Office of Sponsored Programs
Detail of Payroll Expenses
For the Month Ending: **SEP 30, 2014**
Project Period: ***10/01/2012*** to ***09/30/2015***

Project: **60036410**
Award: **GRT00028365**
Sponsor: **US Department of Energy**
Grant/Contract: **DE-FE0009949**

Project/Award Title: **New approach to understanding the occurrence and volume of natural gas hydrate in the northern Gulf of Mexico using petroleum industry well logs**

	Employee						Sponsor Expenses
Account	ID	Name	Journal ID	Journal Date	Pay Type	Description	This Month
60092	200299301	Majumdar,Urmi	0003664787	09/30/2014	HR Monthly	Payroll Expense	1,827.22
						Total for Account	1,827.22
60131	200208533	Ismail,Samrya A	0003664782	09/05/2014	HR Bi-Weekly	Payroll Expense	96.80
						Total for Account	96.80
60135	200208533	Ismail,Samrya A	0003664783	09/19/2014	HR Bi-Weekly	Payroll Expense	245.30
60135	200180848	Scharenberg,Mackenzie Lee	0003664782	09/05/2014	HR Bi-Weekly	Payroll Expense	94.50
						Total for Account	339.80
60292			BNRF700668	09/30/2014	Other	OSURF BENEFIT RATE 5	197.34
						Total for Account	197.34
60331			BNRF500505	09/30/2014	Other	OSURF BENEFIT RATE 5	10.45
						Total for Account	10.45
60335			BNRF401449	09/30/2014	Other	OSURF BENEFIT RATE 4	57.43
						Total for Account	57.43
						Total for Project	**2,529.04**

Table 4. Detail of payroll expenses for Year 2, Q4.

CONCLUSION

Most tasks are on track and the results of this project are being disseminated through presentations and publications.