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Temporal Characterization of Hydrates System Dynamics beneath Seafloor Mounds: Integrating Time-Lapse Electrical Resistivity Methods and In Situ Observations of Multiple Oceanographic Parameters

Project Period: October 1, 2012 – January 31, 2015

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RESEARCH PERFORMANCE PROGRESS REPORT

Temporal Characterization of Hydrates System Dynamics beneath Seafloor Mounds: Integrating Time-Lapse Electrical Resistivity Methods and In Situ Observations of Multiple Oceanographic Parameters

ACCOMPLISHMENTS:

Major objectives of the project are to:
1) characterize, geophysically, the sub-bottom distribution of hydrate and its temporal variability and,
2) contemporaneously record relevant environmental parameters (temperature, pressure, salinity, turbidity, bottom currents and seafloor microseismicity) to investigate possible links of the variability to climate.
In order to achieve these overall objectives, we have identified the following goals:

a) employ the Direct Current Resistivity (DCR) method as a geophysical indicator of hydrates,
b) identify hydrate formation mechanisms in seafloor mounds,
c) detect short-term changes within the hydrates system,
d) illuminate relationships/impacts of local oceanographic and microseismic parameters on the hydrates system and, indirectly, the benthic fauna,
e) monitor fluid/hydrate motion and seafloor instability that these changes might produce.

Accomplishments achieved in relation to these goals include the following (Quarter 1):

- Completion and acceptance of the Project Management Plan; successful "kick-off,"
- Successful completion and testing (at sea) of the I-SPIDER (patent pending), a new deployment and surveying system,
- Beginning of the assembly and evaluation of existing data from the research site at MC118,
- Renovation of the Direct Current Resistivity (DCR) cable in preparation for the September survey.

Accomplishments achieved in relation to these goals include the following (Quarter 2):

- We have used the I-SPIDER, the Integrated Scientific Platform for Instrument Deployment and Emergency Recovery, successfully on three successive cruises both surveying and deploying instruments;
- CMRET's shop and SDI's shop have coordinated effort to build the communications software that will enable us to have live communication with the DCR array while in survey mode;
- We have completed the consolidation of electronics into a single "topside system" that greatly increases our ability to control and monitor at-sea operations;
- We have installed Ultra-short Baseline (USBL) transponders in the hull of the R/V *Pelican* to maintain our exceptional navigation/locating capabilities while at sea;
- We have made significant progress in processing the 2013 multibeam data from MC118;
- We have established a processing protocol for the new polarity-preserving chirp data from MC118;
- We have begun to build the Integrated Portable Seafloor Observatory (IPSO) lander;
- We have determined what caused the resistivity instrument to flood in the summer of 2012;
- We have made repairs to the damaged resistivity system resulting from the flooding event;
- We have devised a solution to the flooding problem;

- We have begun work to devise a means whereby operation of the array can be accomplished autonomously while on the seafloor;
- We have scheduled two cruises for 2014 on the R/V Pelican: April 7-12 and October 3-6.

Accomplishments achieved in relation to project goals include the following (Quarter 3):

- We have completed the survey-mode communications electronics;
- We have upgraded the SSD and I-SPIDER individually and as a tandem system;
- We have selected primary and secondary target sites for the DCR survey and have plotted the proposed survey;
- We have built the IPSO lander frame, researched and ordered instruments and installed them on the IPSO lander;
- We have begun processing the new polarity-preserved chirp data from MC118;
- We have completed repairs to the seafloor DCR system associated with the housing flooding that occurred in July 2012;
- SDI replaced the power and control through-housing connector to the DCR instrument with one that has higher current capacity;
- We have devised a system whereby the DCR system will be controlled remotely while on the seafloor;
- SDI built the Atom control computer and installed it in a pressure housing;
- We have developed/acquired new control software for autonomous operation of the DCR instrument;
- We have built a stand that will hold the DCR instrument electronics and housing end-cap in an inverted position while assembling the DCR housing.

Accomplishments achieved in relation to project goals include the following (Quarter 4):

- We have inventoried data from MC118 that has and will continue to inform our survey and deployment strategies;
- We have established a processing protocol for the polarity-preserving chirp data from MC118;
- We have designed and begun acquiring components for the replacement battery system for the IPSO;
- We have completed a paper describing the new resistivity data processing method that will be used to process the targeting data as a 3D data set;
- We have developed a data acquisition and communication and control system to allow long term deployment of a DC resistivity array on the sea floor;
- We have submitted a no-cost extension request to complete Year 1 work that has been approved.

Accomplishments achieved in relation to project goals include the following (Quarter 5):

- We have completed the electronics integration for command and control throughout survey and deployment/monitoring modes;
- We have tested the joint operation of the IDP, the control computer, and the resistivity instrument in the remote-control and autonomous monitoring mode of operation;
- We have built/modified a deployment system for the 1000m long DCR array;
- We have a plan for processing initial reconnaissance DCR data;
- We have a plan in place for the cruise to collect survey data and to place the DCR array and lander for a 6-month data-collecting period.

Accomplishments achieved in relation to project goals include the following (Quarter 6):

- We completed the construction and assembly and installation of sensors for the IPSO;
- We planned and conducted a successful cruise to MC118, April 9-12;
- We have made an experimental and successful use of a new/modified deployment system for the 1000m long DCR array;
- We collected four ~1km-long resistivity profiles in survey mode;
- We completed initial analyses of the survey lines;
- We selected the monitoring site, adapted the lander for monitoring mode, and deployed the IPSO-DCR assembly at the monitoring target;
- We successfully executed the continuation presentation;
- We have a No-Cost Extension in place;
- We have reprocessed initial survey data with a variety of filters.

Accomplishments achieved in relation to project goals include the following (Quarter 7):

- We planned and executed a cruise to MC118 to recover the DCR array and IPSO lander;
- We successfully recovered all systems ahead of schedule, by partnering with another agency's late-scheduled cruise;
- The long term data acquisition and communication and control system for the DC resistivity array on the sea floor successfully recorded the data from the DCR;
- We recovered 2 time-lapse DCR data files (images/profiles of the subbottom);
- Two DCR profiles have been processed in time-lapse mode showing that locations of high resistivity anomalies changed from one week to the next;
- The IPSO electronics successfully collected and stored data from the oceanographic sensors;
- We managed to have the failure of the DCR array isolated;
- We completed a cruise report for the April cruise detailing the deployment of the DCR/IPSO system (http://mmri.olemiss.edu/Home/Publications/Cruise.aspx);
- We completed a cruise report for the August-September cruise detailing the recovery of the DCR/IPSO system (http://mmri.olemiss.edu/Home/Publications/Cruise.aspx).

Accomplishments achieved in relation to project goals include the following (Quarter 8):

- We worked with DOE to amend the project, as per their request, to end early, following our determination that the DCR cable was not fit for a follow-up deployment;
- We revised the SOPO and budget for the abbreviated project schedule;
- We contacted and reached an agreement with a skilled data analyst to do the initial cleaning of the oceanographic data (in the absence of the student, budgeted to do this part of the project) and recovered the data from the instruments and transferred the files to him;
- We –Baylor and SDI - did the initial analysis of the DCR cable then sent it to AGI to have them perform their analysis.
- We prepared and submitted for publication the results of this and previous seafloor resistivity projects to document what we have found and to serve as a starting point for future studies of near seafloor hydrate systems.

We worked with DOE to amend the project, as per their request, to end early, following our determination that the DCR cable was not fit for a follow-up deployment

Following the August-September cruise, we investigated the causes of failure of the DCR array. Dunbar and Xu found all 56 conductors to have failed, although they could not determine when. The data collected during the first weeks of the experiment prove that the failure did not occur until after the computer glitch stopped the recording of profiles three weeks into the deployment. Lutken notified the

DOE Project Manager, opening discussion on how to proceed with the project. It appeared that there were three possible routes to follow:
1. redesign and rebuild the array putting the rest of the project on "hold" for around a year (we would contract this out to someone other than AGI who built the array that failed. Higley and Lutken both know companies that do this); 2. with the existing 500m survey array, survey in October and again in April to build a 3-D volume of the known shallow hydrate at MC118, as well as time-series data for that volume (2 datasets), 3. Halt the project and write a final report.
Options 2 and 3 could be done with existing funds. 1 would require some additional funds and/or rebudgeting. We determined that it would be possible to rebudget the project and devote about $60,000 to rebuilding the DCR array. However, DOE – our Manager together with others in the Methane Hydrates Division – decided that the additional year that a rebuild would require, was more time than they were willing to allow, to keep the project going. Lucas Payne, DOE Contract Specialist, directed us to terminate the project and sent instructions on how that would be done, including determining a new project end-date, rewriting the project Statement of Project Objectives, and rebudgeting funds on hand to support the remaining work.

We –Baylor and SDI - did the initial analysis of the DCR cable then sent it to AGI to have them perform their analysis
Dunbar and graduate student Tian Xu conducted work to understand the cause of the equipment failure during the Summer 2014 time-lapse deployment of the seafloor resistivity system to document what the project has shown, both positive and negative, to serve as a starting point, for any future studies of near seafloor hydrate systems.

In April, 2014, the seafloor resistivity system had been deployed over a target resistivity anomaly at MC118 to conduct a time-lapse study of sub-bottom changes in the hydrate system. In September, 2014, the system was recovered from the seafloor and brought back to shore for inspection and maintenance, with the intent of re-deploying the system during a scheduled follow-up cruise in October, 2014. However, in preliminary testing at Baylor University, it was discovered that there had been loss of continuity between all 56 electrodes on the electrode array and corresponding pins in the high-pressure connectors to the instrument housing. This was a complete surprise. The array, which had been built in 2008, had been used successfully in a 36-hour deployment in 2009 and a 24-hour deployment in April 2014 and had performed satisfactorily in weeks-long bench tests prior to the April deployment. Because this loss of continuity to the electrodes was not a problem that could be fixed before the planned re-deployment cruise, the project was ended.

During this quarter the array was transported to the manufacturer, Advanced Geoscience, Inc., of Austin, Texas, for a full set of diagnostic tests. AGI’s tests confirmed the initial results, that electrical continuity had been lost between the connectors and all 56 electrodes. The conclusion was that during the 5-month long deployment in the summer of 2014, seawater penetrated the graphite electrodes and caused corrosion to occur at the connection between the graphite electrode and copper pins that form the electrical connections to the cable conductors (Figure 1). The copper pins are pressed into holes drilled into the graphite and soldered to a conductor, which is connected to the resistivity instrument. Then the whole electrode assembly is potted with urethane to prevent any water that penetrates the interior of the cable from getting to the connection. This approach worked sufficiently well to allow seafloor operations of days, but apparently not for longer deployments. Graphite was chosen for the electrode material specifically to avoid electrode corrosion during long deployments for time-lapse measurements. The problem appears to be that the graphite is sufficiently permeable that under the pressure conditions at water depths of 1 km, seawater is able to penetrate the graphite, however slowly, and reach the copper pin during longer deployments. Then, while the electrode is used as a source to inject 2 Amp current into the water, the copper pin rapidly corrodes. The corrosion of the connecting pin was suggested by bright green copper oxide smudges that were visible on the outside of each electrode as the array was being retrieved from the seafloor in September, 2014. The solution to this problem would be to switch to an impermeable electrode material. However, long testing periods at high pressure in salt water would be required to verify the performance of any new electrode array design. Such a re-design and testing program were determined by the funding agency to be beyond the scope of the current project. Hence, termination of the project was reasonable.

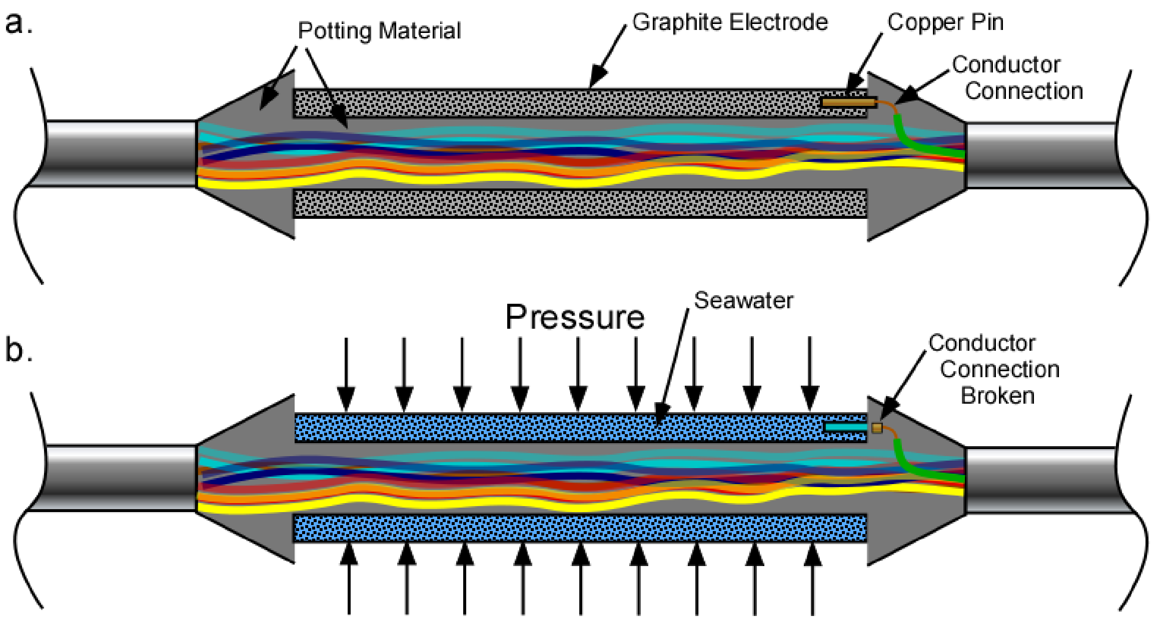

Figure 1. Cutaway diagram of seafloor electrical resistivity electrode. (a) The electrodes on the seafloor resistivity array are hollow cylinders of graphite. Each electrode is connected to one of 56 dedicated conductors, which extends from the electrode to the connector at the instrument end of the array (to the right). The conductors for all other electrodes toward the tail end of the array (left) pass through the center of the electrode. The connection between the copper conductor (green) and the graphite electrode is made by soldering the conductor to a copper pin that is pressed into a hole drilled into the graphite. The connection is then potted to hold the electrode in place and to seal the connection point from any seawater that may have penetrated the jacket of the cable to the left or right of the electrode. (b) Under long deployments at high pressure seawater penetrates the graphite electrode and envelopes the copper pin, which rapidly corrodes when the electrode is used as a source, leading to a break in the connection to the conductor.

We prepared and submitted for publication the results of this and previous seafloor resistivity projects to document what we have found and to serve as a starting point for future studies of near seafloor hydrate systems.

We prepared a manuscript for publication in *The Leading Edge* describing the results of the current and previous seafloor resistivity project (Xu et al., 2015). This article describes the seafloor resistivity method implemented in the continuous resistivity profiling (CRP), fixed array profiling, and time-lapse

profiling modes. Data collected at MC118 in June 2009, April 2014, and May 2014 during the time-lapse deployment are used to illustrate the application of these methods to the study of near-seafloor hydrates. The paper has been accepted for publication and will appear in a special issue devoted to new developments in near surface geophysics in 2015.
Xu, T., Dunbar J., Gunnell, A. Lutken, C., Higley, P. and Lagmanson, M., Seafloor direct current techniques for deep marine, near-bottom gas hydrate investigation, *The Leading Edge*, In press Dec., 2014.

We revised the SOPO and budget for the abbreviated project schedule
In conversation with COE Skip Pratt, we determined January 31, 2015 as the new project end-date, revised the SOPO and budget to allow us to extract and attempt to analyze data collected by the DCR and the oceanographic data collected with the deployed Integrated Portable Seafloor Observatory, or IPSO lander. We also confirmed items ***not*** to be completed in the original SOPO (e.g. Task 5-8, etc.).

We contacted and reached an agreement with a skilled data analyst to do the initial cleaning of the oceanographic data (in the absence of the student, budgeted to do this part of the project) and recovered the data from the instruments and transferred it to him
We worked with the manufacturers of the instruments to get the data off the oceanographic instruments and into correct formats for data analyses. This was particularly challenging for the ADCP data as the software had been updated and not noted in the manual. Brad Battista, EnerGeoSolutions, has performed cleaning and initial analyses of all data types. He is performing various trend analyses and producing trial graphics to illustrate data difficulties and inconsistencies as well as results.

MILESTONE CHART:

Milestones A, B, C, D and E are complete. The cancellation of the second deployment of the IPSO and DCR array make Milestone F no longer appropriate.

Milestone	Planned Completion	Actual Completion	Verification Method	Progress/Deviation from Plan
Milestone A: Target sites selection for IPSO deployment at MC118	9/15/2013	9/17/2013	4 targets identified	2 days
Milestone B: Successful testing of the DCR cable in a pressure-testing facility – SW Research Institute or comparable.	9/15/2013	9/11/2013	Successful test of the DCR system at 1000m water depth equivalent	
Milestone C: Successful testing of a new Integrated Portable Seafloor Observatory (IPSO).	9/15/2013	9/25/2013	Successful onshore test of IPSO	10 days
Milestone D: Successful deployment of Integrated Portable Seafloor Observatory (IPSO).	4/30/2014	4/12/2014	Proper orientation and functioning of IPSO	
Milestone E: Recover data from MC118 with the IPSO	10/31/2014	9/3-4/2014	IPSO recovered with data	8 weeks early
Milestone F: Recover data from MC118 with the IPSO	4/30/2015	NA	IPSO recovered with data	2nd deployment not approved by DOE
Milestone G: Complete analysis of temporal characterization of hydrates system dynamics at MC118	10/31/2015		Resistivity and temporal data produce reasonable temporal analysis	

Milestone H: Complete final report and submit to DOE	1/31/2016		Report accepted by COR	

PRODUCTS:

A new lander, the Integrated Portable Seafloor Observatory, or IPSO;
oceanographic instruments for the IPSO;
A new cable-deployment system for the DCR;
Command and control hardware and software;
A 1100m long DCR cable-array;
Cruise report of April's activities, http://mmri.olemiss.edu/Home/Publications/Cruise.aspx;
Raw and processed resistivity data from a hydrates mound.
Cruise report of August-September activities, http://mmri.olemiss.edu/Home/Publications/Cruise.aspx;
Initial time-lapse resistivity data with areas and percentage change over time.
A publication in a special issue of *The Leading Edge*: Xu, T., Dunbar J., Gunnell, A. Lutken, C., Higley, P. and Lagmanson, M., Seafloor direct current techniques for deep marine, near-bottom gas hydrate investigation, *The Leading Edge*, In press Dec., 2014.

PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS:

During this quarter, personnel from the University of Mississippi and from Baylor University participated in the project. Their contributions are as follows:

Name: Carol Lutken
Project Role: PI, University of Mississippi
Nearest person month worked: 2
Contribution to Project: Lutken executed communications between participants and with DOE. She worked with the MMRI shop to complete the assessment of the equipment and recover the data from the sensors on the lander. She worked with DOE Project Manager and the Contracts Officer to establish the new deadline for the project, wrote the new SOPO and task justifications, and established the conditions for the new budget. She compiled information for and wrote the quarterly progress report.

Name: Marco D'Emidio:
Project Role: Scientist, University of Mississippi
Nearest person month worked: 2
Contribution to Project: D'Emidio worked to remove all instruments from the IPSO lander and to retrieve data from the sensors on the lander. He worked with manufacturers to overcome the hurdles to data-recovery, configure the data in proper formats for analyses and to transfer the data to the subcontractor for initial cleaning and analyses. He continues to maintain constant contact with the subcontractor and works with him to overcome challenges of data noise and inconsistencies.

Name: Steven Tidwell
Project Role: Research Associate, University of Mississippi
Nearest person month worked: 0
Contribution to Project: Tidwell is the MMRI/CMRET shop research associate with a degree in geological engineering and expertise in machining and electronics as well as computer software. With the departure of Lowe from MMRI in August, Tidwell became chief engineer on this project, directing both shop activities and deck activities at sea. During this quarter, he completed the demobilization of the

sensors and lander and has worked with the visual data to recover imagery that will be used in final analyses of the lander data.

Name: Jeremy Dew
Project Role: Research Associate, University of Mississippi
Nearest person month worked: 0
Contribution to Project: Jeremy is a geologist with extensive shop experience. He assisted Tidwell in the demobilization of the shop equipment, the lander and the sensors on the lander.

Name: Larry Overstreet
Project Role: Electronic Technician, University of Mississippi
Nearest person month worked: 0
Contribution to Project: Larry is experienced in fiber-optics work including cable terminations and systems integration. He is also an accomplished machinist who designed and built the grapnel used in the successful recovery of the DCR/IPSO system. He assisted Tidwell in the demobilization of the shop equipment, the lander and the sensors on the lander.

Name: John Dunbar
Project Role: Co-I, Baylor University
Nearest person month worked: 1
Contribution to Project: Dunbar established the means to test the array for continuity and connection and carried out the tests. He transported the array to sites where external tests were executed, including AGI. He is Xu's director and worked with him on the form and content for the Leading Edge paper. Dunbar and Xu have completed initial processing of the data recovered during the cruise.

Name: Tian Xu
Project Role: Graduate student, Baylor University
Nearest person month worked: 2
Contribution to Project: Xu works with Dunbar to define the processing of resistivity data collected during survey and monitoring modes. Xu took the lead on the processing of the resistivity data and in preparing for and writing the *Leading Edge* paper.

Name: Paul Higley
Project Role: Co-I, Specialty Devices, Inc.
Nearest person month worked: 0
Contribution to Project: Higley, an ocean engineer, works in all aspects of pre-cruise and cruise activity. During this quarter, he participated in the post-cruise diagnosis of the DCR cable.

Name: Scott Sharpe
Project Role: Electronics specialist, Specialty Devices, Inc.
Nearest person month worked: 0
Contribution to Project: Sharpe heads the electronics and programming staff at SDI. He redesigned the IDP for this project, programmed and reprogrammed the components for the cruise and for monitoring mode. He developed the data acquisition and communication and control system to allow long term deployment of a DC resistivity array on the sea floor. During this quarter, he participated in the post-cruise diagnosis of the DCR cable.

Name: SDI Technical staff

Project Role: Electronics and technical support, Specialty Devices, Inc.
Nearest person month worked: 0
Contribution to Project: No contribution this quarter.

IMPACT:

The analyses of the DCR array took place in three parts. The initial aanalysis was performed at Baylor and all 56 connections in the nodes had lost their connectivity. This was borne out in a follow-up analysis at SDI, Inc. and again by AGI. As expected, AGI determined that the failure of the array resulted from the failure of graphite to perform as an insulator over time and at 900m water depth. Even this failure does not negate the success of the overall project design. Should a more robust (and expensive, in all cases so far investigated) insulator be built into the array, and the computer software hang overcome – something that should not be difficult in terms of time, effort or expense – this monitoring system should perform successfully at this depth and over the 6-month period. ***The results of the time-lapse data analyses accomplish the primary objective of the project: to image shallow hydrate and to illustrate its temporal variability.***

In spite of the successes of this first effort to recover data using the DCR array and instrument in monitoring mode, the failure of the array to withstand the extreme conditions of the long-term seafloor deployment have resulted in the DOE's decision to terminate the project early, rather than to have us attempt to rebuild the array using more robust insulating material. We are doing our best to make the most of the acquired data – both resistivity and oceanographic parameters – by early 2015. We anticipate that the shallow chirp profiles we have in hand will help determine possible geological/geophysical explanations for the profound changes observed in the shallow hydrate distribution over the brief period of investigation in monitoring mode. It is clear that this system holds great promise as a prospecting tool for shallow hydrates.

CHANGES/PROBLEMS:

The project, although terminated early, has already produced impressive results. The data recovered from the oceanographic instruments only during the successful collecting window of the resistivity instrument, are being analyzed for consistencies and inconsistencies, trends, anomalies and drift. Noise has been removed from all datasets. The failure of the cable has been determined to be owing to the failure of the graphite to function as an insulator of the nodes in the DCR array over extended time. Salt water was able to penetrate the nodes causing them all to corrode. Although the array could be rebuilt with copper or other insulator in place of the graphite, this would involve additional time in excess of 6 months beyond the current schedule. We realize that DOE does not support this delay and we are making every effort to make the most scientifically productive use of the time between now and the new end-date of January 31 to evaluate the oceanographic data, the resistivity data and to integrate the two. Interpretation will involve the use of subbottom data already in-hand.

SPECIAL REPORTING REQUIREMENTS:

None noted.

BUDGETARY INFORMATION:

The expenses incurred during this quarter have been charged to both direct charges and cost-sharing. Subcontractor Higley did not charge to the project this quarter. Please see the budget report spread sheet, below.

DOE Hydrates FY12 DE-FE0010141 Baseline Reporting by Quarter	Budget Period 1 (Actual Cost Share Corrected)										Budget Period 2								Budget Period 3			
	Quarter 1 - Corrected		Quarter 2		Quarter 3		Quarter 4		Quarter 5		Quarter 1		Quarter 2		Quarter 3		Quarter 4		Quarter 1		Quarter 2	
	1/1/13 - 3/31/13		4/1/13 - 6/30/13		7/1/13 - 9/30/13		10/1/13 - 12/31/13		1/1/14 - 3/31/14		4/1/14 - 6/30/14		7/1/14 - 9/30/14		10/1/14 - 12/31/14		1/1/15 - 3/31/15		4/1/15 - 6/30/15		7/1/15 - 9/30/15	
	Q1	Cumulative Total	Q2	Cumulative Total	Q3	Cumulative Total	Q4	Cumulative Total	Q5	Cumulative Total	Q1	Cumulative Total	Q2	Cumulative Total	Q3	Cumulative Total	Q4	Cumulative Total	Q1	Cumulative Total	Q2	Cumulative Total
Baseline Cost Plan																						
Federal Share	127,121	127,121	127,120	254,241	209,200	463,441	127,120	590,561	-	590,561	105,994	696,555	82,926	779,481	165,006	944,487						
Non-federal Share	36,912	36,912	36,912	73,824	36,912	110,736	36,912	147,648	-	147,648	28,973	176,621	26,747	203,368	26,747	230,115						
Total Planned	164,033	164,033	164,032	328,065	246,112	574,177	164,032	738,209	-	738,209	134,967	873,176	109,673	982,849	191,753	1,174,602						
Actual Incurred Cost																						
Federal Share	-	-	8,592	8,592	86,331	94,923	201,745	296,668	42,214	338,882	74,615	413,497	146,404	559,901	40,201	600,102						
Non-federal Share	9,641	9,641	16,529	26,170	-	26,170	21,150	47,320	14,121	61,441	10,843	72,284	41,363	113,647	8,928	122,575						
Total Planned	9,641	9,641	25,121	34,762	86,331	121,093	222,895	343,988	56,335	400,323	85,458	485,781	187,767	673,548	49,129	722,677						
Variance																						
Federal Share	127,121	127,121	118,528	245,649	122,869	368,518	(74,625)	293,893	(42,214)	251,679	31,379	283,058	(63,478)	219,580	124,805	344,385						
Non-federal Share	27,271	27,271	20,383	47,654	36,912	84,566	15,762	100,328	(14,121)	86,207	18,130	104,337	(14,616)	89,721	17,819	107,540						
Total Planned	154,392	154,392	138,911	293,303	159,781	453,084	(58,863)	394,221	(56,335)	337,886	49,509	387,395	(78,094)	309,301	142,624	451,925						