

Oil & Natural Gas Technology

DOE Award No.: DE-FE0010180

Quarterly Progress Report (Period ending December 31th, 2013)

Gas Hydrate Dynamics on the Alaskan Beaufort Continental Slope: Modeling and Field Characterization Project Period: October 1, 2012 – September 30, 2015

Submitted by:

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Prepared for:
United States Department of Energy
National Energy Technology Laboratory

February 1st, 2014



Office of Fossil Energy

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ABSTRACT

FY2014 first quarter research associated with the DE-FE0010180 grant required progress on three fronts, all of which were associated with preparation for the upcoming summer 2014 cruise. Specifically, the first quarter of FY2014 was dedicated to (1) scientific preparation for the cruise by testing equipment, receiving tool training, and further model development at SMU, (2) continuing pre-cruise artificial methane seep experiments at OSU, and (3) securing a ship contract for the MV Norseman II. Scientifically, significant progress was made on several fronts, with further model development at SMU and continued experimental advancement of an artificial methane seep site at OSU that we will use to ground truth results for the upcoming cruise. Additionally, during the past quarter, SMU and USGS researchers presented preliminary results from the DOE study at two international conferences. Unfortunately, we encountered significant problems securing a ship contract this past quarter. Currently, we have not yet secured a ship contract for next summer's research cruise. The delay in signing the ship contract stems from two key concerns that have arisen during the past quarter involving the M/V Norseman II. These concerns center on (1) the ship's winch capabilities and (2) the ship's fantail space. Specifically, the MV Norseman II's primary winch load limit is below USGS piston coring system requirements. Additionally, after USGS personnel visited the ship, it became clear that the fantail length of the Norseman II is ~5 ft shorter than original ship specifications suggested (likely due to a recent ship retrofit and outdated ship specification sheet). As a result, the fantail was also not long enough for the USGS piston coring system. Colleagues at the USGS have spent significant time and effort this past quarter searching for other research vessel options, and this search is ongoing today. Although we hope we are still able to find a suitable vessel for this summer, we are also developing contingency plans. Assuming no rapid solution to ship contracting issues emerges in the coming weeks, we outline in our conclusions a revised set of potential milestones and associated deliverables for the end of FY2014. An upcoming meeting between PIs and our DOE technical project manager in February will help further clarify a path forward for year 2 research.

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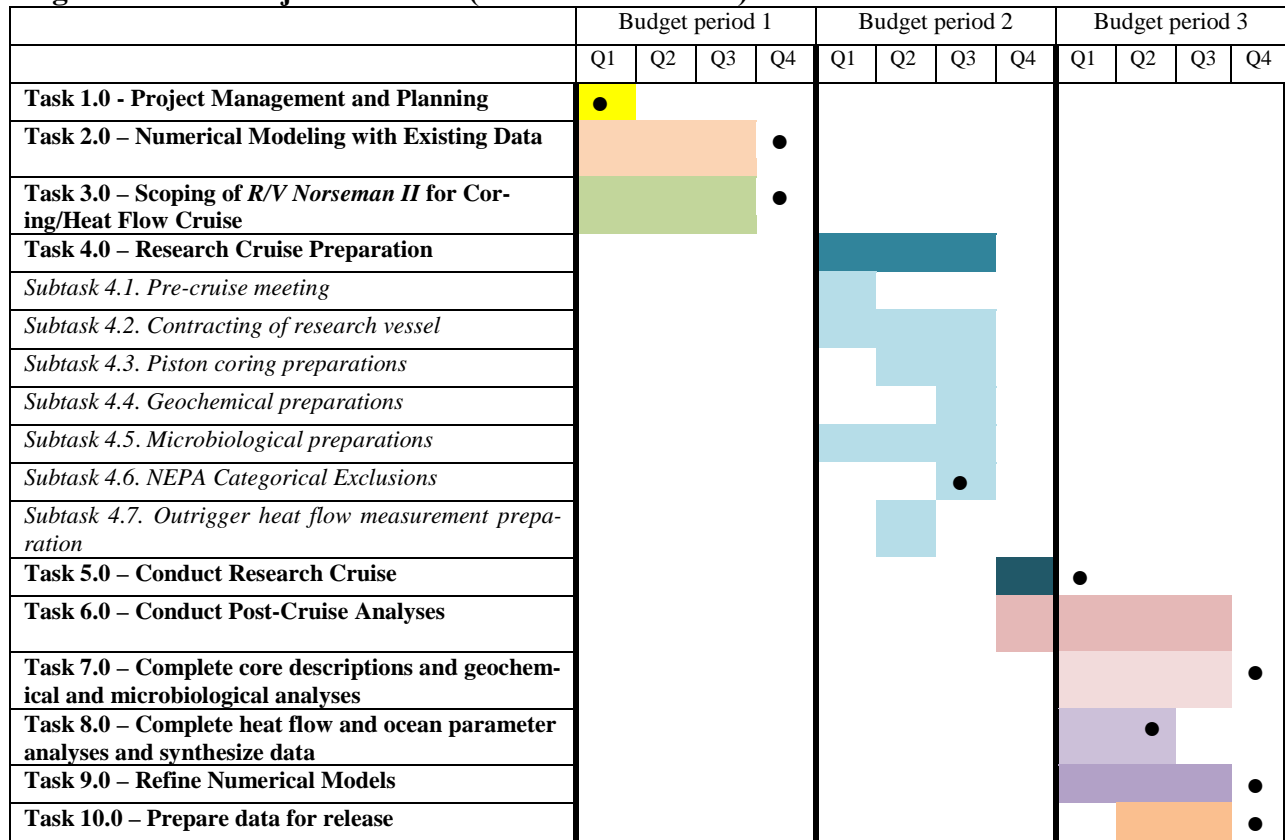
EXECUTIVE SUMMARY

In October 2012, Southern Methodist University in close partnership with The United State Geological Survey at Woods Hole and Oregon State University, began investigating methane hydrate stability in deep water (>100 mbsf) environments below Alaskan Beaufort Sea. This research is part of a three-year study funded by the Department of Energy’s (DOE) National Energy Technology Laboratory (NETL). Key goals of this study include integrating and processing marine seismic data collected at the USGS with dynamic 2D/3D/4D heat flow models developed at SMU to determining the depth, location, and dynamics of methane hydrate stability along the Alaskan Beaufort Margin. A key component of this study is to constrain how the methane hydrate stability zone is changing with time. Additional goals of this study include determining areas where concentrated methane hydrate might exist in the subsurface and to understand the role methane hydrate plays in slope stability along the Alaskan Margin.

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PROGRESS AND RESULTS

Figure 1. PMP Project Timeline (with deliverables ●)



Primary project goals for the first quarter of year two of this project, as outlined in figure 1 of the project management plan (shown above) all focused on preparing for the up-coming cruise (Task 4), and consisted of three subtasks (4.1, 4.2, and 4.5) defined below:

Subtask 4.1—Conduct a pre-cruise planning and preparation meeting.

Subtask 4.2—Obtain a contract with the research vessel

Subtask 4.5—Microbiological Preparations.

Results of Subtask 4.1: Conduct a pre-cruise meeting

Completed. In November of 2013, we held a series of teleconferences in November and December that included researchers and ship operators to further prepare for the upcoming cruise. The first of these teleconferences, held November 12, was with the USGS, SMU, and the operators of the Norseman II. This was followed up with phone calls and conference calls between PIs on the grant. The discussion of these calls focused on ship logistics and timing. By mid-November, we had locked in cruise dates on the MV Norseman II that fell in the most ideal weather window

(mid-September). We had also locked-in ideal mobilization/demobilization port calls that we believed would save significant time and expense. Additionally, we discussed during the conference calls the logistics of possibly transporting additional microbiological sampling and analysis equipment to the Norseman II. We also scheduled a time for Hornbach and Ruppel to visit the heat flow facility at UC-Santa Cruz to receive pre-cruise training using the outrigger heat flow probe equipment (the original plan was to visit in late January). Finally, we discussed a timeline for completion of contracting and payment to the Norseman II, with the goal of completing contract negotiations by the end of this quarter.

Results of Subtask 4.2: Obtain a contract with the research vessel.

Incomplete. In late November (the day before thanksgiving), concerns were raised by the USGS that there may be problems with the R/V Norseman II as a potential research platform. The initial issue involved the ship's primary winch, which was underrated for expected coring needs. Initially, our goal was to supply the ship with a larger winch system. Ultimately, other problems with the Norseman II emerged. In particular, the discovery that we were provided outdated deck-space drawings of the ship's fantail raised several major concerns regarding the viability of the ship as the appropriate research platform for coring. As a result, colleagues at the USGS spent the last 6 weeks reassessing the Norseman II's capabilities, and looking for possible solutions (or alternatives).

Below is a detailed summary provided by the USGS explaining how the ship contracting situation evolved during Q1 FY14:

The discussions among SMU, the USGS, and the anticipated ship operator on 12 November 2013 were positive and professional and followed from a scoping exercise completed as a deliverable for DOE in August 2013. We received assurances that we could work from Deadhorse/Prudhoe Bay, which would save on transit costs, allow the USGS to stage equipment from a port that they know well, and permit most large equipment to go up the Dalton Highway (haul road), the only road on the Alaskan North Slope. We also were promised our optimal operations window, which coincided with anticipated low ice in mid-September 2014. In short, the situation was far better than we could have hoped for.

Despite the ship having been formally scoped (drawings, discussions, and other assessments) in summer 2013, a critical component had been overlooked. At the end of November 2013, we were notified by USGS Pacific Coastal and Marine Science Center operations staff that, while the A-frame on the originally chosen vessel was rated to 18,000 lbs, the winch was not sufficient to accomplish the piston coring with the USGS rig. During the ensuing 6 weeks, we took the following measures: (a) pursued alternate leased winches equipped with full hydraulics, tensiometer, wire-out reading, etc. that could be installed temporarily on the original ship (not uncommon); (b) explored alternate methods of coring or alternate corers that might be lighter weight; and (c) explored some alternate vessels. Installing another winch on the original vessel, while not ruled out by the operator, could have created potentially problems known to those of us who have spent decades going to sea. Still, we did pursue this option.

On January 8, 2014, USGS operations personnel visited the originally-identified vessel in winter quarters in Southern California. During this trip, they measured the fantail, which turned out to

be 5' shorter than anticipated. This meant that even a shortened version of the USGS coring track could not be accommodated. At this point, with both the fantail and the winch problems, we regretfully informed the ship operator that we would be unable to move forward.

We immediately investigated and quickly abandoned the idea of gravity coring, which has not previously been successful on the Beaufort slope, a very challenging setting for coring. The focus of the cruise is coring, and it is important to get the best quality cores for this program.

On January 13, 2014 a group of operations personnel in Woods Hole were mobilized to investigate all possible remaining options. Many alternate vessels were considered, although this was difficult given the paucity of available ships in this operating theater. Numerous Alaskan marine community contacts honed over the past 5 years provided advice about possible vessels for hire. A list of appropriate for-hire research vessels was contacted, mostly based out of Seattle and requiring full transit rate to the Beaufort area. This would have used up all available ship funding without any science having been accomplished. Ships owned by some other state and federal government agencies were also investigated and deemed unsuitable for coring due to size, lack of fantail, lack of deck handling equipment, or lack of experience operating this far offshore in the Beaufort Sea. Ships without A-frames were considered since the USGS was willing to entertain using an along-gunwale cradle system, instead of a track system, for the piston coring. The marine superintendent for a UNOLS ship operating south of the Bering Strait in summer 2014 was contacted about their interest in the Beaufort program, but the winch was rated at only half the necessary amount. Ruppel filed a ship time request in the UNOLS system as a placeholder in case another vessel could be found, and she contacted personnel at the USCG to investigate the availability of an icebreaker. During the week of January 19-25th, the USCG, in the spirit of interagency cooperation, made every effort to accommodate our program in the 2014 Arctic schedule, but we learned on January 24, 2014 that this would not be possible.

Results of Subtask 4.5: Microbiological Preparations.

Continuing and ahead of schedule. OSU researchers are ahead of schedule in their cruise preparations and continue to develop and analyze data at an artificial methane seep that we will use to ground-truth upcoming cruise-related microbiology results. Much of the work conducted at OSU this past quarter was expected to take place later in FY2014 or even FY2015 of the study; OSU has therefore made significant early strides with the development of the artificial methane seep system. As stated in our conclusions section, a revised goal for FY2014 is that OSU will be able to submit some of their initial results to the Fall AGU meeting.

ADDITIONAL PRODUCTS AND RESULTS

Additional Numerical Modeling Progress

Researchers at SMU have spent the past Quarter updating the 3D heat flow model so that it solves diffusive heatflow equation using implicit (inverse) methods. We are currently running benchmark tests comparing implicit numerical heat flow results with explicit finite-difference results. We are also comparing results to analytical solutions to determine (1) which method provides the most accurate technique for calculating subsurface temperature in the Beaufort Sea and (2) which technique provides the fastest run time for the numerical accuracy we require. We will use these results to determine which model approach is best suited for 2D and 3D heat flow analysis of the 2012 sparker data we will begin analyzing during Q2 FY2014.

Invited Oral Presentation at PERGAMON

In November, SMU researchers were invited to attend and present initial results from the DOE study at the PERGAMON (Permafrost and gas hydrate related methane release in the Arctic and impact on climate change) meeting. This meet was held from the 5-7th of November in Kiel, Germany. PERGAMON paid all costs for SMU researchers to present DOE results, and Hornbach had SMU graduate student and lead author, Benjamin Phrampus, present SMU research at this conference. The invited talk was titled, “Alaskan Beaufort Sea Heat Flow and Ocean temperature analysis: implications for stability of climate sensitive continental slope gas hydrates.”

Oral Presentation at American Geophysical Union Fall Meeting

In December, 2013, SMU and USGS researchers presented preliminary results of DOE research at the annual AGU fall meeting, held in San Francisco, California. The research was presented in a special oral presentation session at AGU entitled, “Sources of Methane in Changing Arctic and Boreal Realms—Wetlands, Fires, Hydrates, Permafrost, Gasfields.” SMU graduate student Benjamin Phrampus was again the lead author and presenter of our research at this session.

COST STATUS

Costs incurred on DOE Grant by SMU (not including SMU matching):

--RA support + fringe for Hornbach's graduate student, Ben Phrampus: \$6,831

--Subcontract to OSU for research support and cruise preparation:\$3,781 (an additional installment was paid in January that hasn't yet been posted).

--Travel for SMU researchers to AGU in December: Not yet posted.

--Overhead: \$2328.62

Total approximate expenditures charged to DOE on SMU Grant in Quarter #1: ~\$12,941.

Total approximate matching support provided by SMU for Quarter #1: ~\$3,674

PROBLEMS OR DELAYS

Delays with ship contracting (as already discussed above).

Our primary delay is with ship contracting. Although the USGS continues to pursue different avenues, currently it appears unlikely that we will be able to secure an appropriate vessel needed to conduct shipboard research for summer 2014. We therefore are making contingency plans. To address how we will move forward, we will have a conference call in February with our technical project manager at DOE, Rob Vagnetti, to discuss possible options. Researchers at UC-Santa Cruz (who will provide the heat flow probe outriggers) have been informed of the potential delay, and they have already confirmed that we should have no problem using the outriggers on a 2015 summer cruise, if necessary, as their schedule is open.

Delays with seismic data processing and analysis

SMU and the USGS are waiting for final processing of 2012 sparker seismic data. The goal is for SMU and the USGS to work together using the 2012 sparker data to compare and model changes in the depth of the hydrate stability zone during the past 35 years (1977 to 2012). This analysis will begin as soon as data processing is completed. We anticipate the key line needed for analysis will be processed and ready for analysis by the GRC conference in Galveston at the end of March.

CONCLUSIONS AND FUTURE DIRECTIONS

Due to ship uncertainties, we are currently revising our milestones and deliverables for FY2014. At present, we list the following potential milestones for the end of FY2014:

Milestone 1 (SMU lead): Completion of numerical modeling of hydrate stability based on comparisons between 1977-2012 USGS datasets. SMU expects to receive a processed line from the 2012 sparker survey by the end of March, and will begin work on that modeling at that time. Deliverables: an initial manuscript in draft form by 9/1/2014.

Milestone 2 (OSU-lead): Complete analyses and synthesize molecular biology data and water chemistry data for artificial methane seeps as model systems where incipient gas flux in sediments causes changes to microbial community structure and recruitment of key microbes. Deliverables: Abstract submitted for presentation at Fall AGU meeting by Aug 1. An initial manuscript in draft form by 9/1/2014.

Milestone 3 (USGS-lead): Identify a ship that we may use as a potential research platform for summer 2015 by 9/1/2014.

Each of these milestones represents a component of the original milestones listed in our statement of purpose for the project, and therefore these milestones represent no changes to the scientific goals or objectives. However, the timing involved in achieving them has changed slightly. For example, milestone 2 was originally supposed to be conducted in year 2 but not fully completed until year 3 of the study. Given the progress made by OSU researchers, we would like to consider tentatively moving milestone 2 into year 2. Further discussion between PIs and our technical project manager during the next few weeks will help us refine the timing and scope of FY2014 milestones.

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