Oil & Natural Gas Technology

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Quarterly Progress Report
(Period ending June 30th , 2016)

Gas Hydrate Dynamics on the Alaskan Beaufort Continental Slope: Modeling and Field Characterization
Project Period: October 1, 2012 –March 31st, 2017

Submitted by:

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ABSTRACT

The 2nd quarter of FY2016 research focused primarily on (1) cruise contracting for the September 2016 Beaufort Sea heat flow cruise, (2) Heat flow equipment preparation and testing, (3) cruise timing, logistics, and station locating and (4) continued AVO analysis assessing pore pressure below hydrate systems on the US Western Atlantic Margin. During Quarter #3, we presented results at a heat flow conference in Dallas. Our paper assessing heat flow evolution and hydrate stability along the Eastern Atlantic Margin is currently in review in *Marine and Petroleum Geology*.

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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. In late 2014, the project was further expanded to include analysis of methane hydrates and slope stability off the US east coast. This research is part of a now 4.5 year study funded by the Department of Energy's (DOE) National Energy Technology Laboratory (NETL) that analyzes methane hydrate stability on both the Atlantic and Beaufort Margin. Key goals of this study include integrating and processing marine seismic data collected at the USGS as well as other publically available data 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 and similar environments. A major 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 continental margins. To accomplish these goals, researchers use geophysical (seismic, heat flow, CTD/XBT) data combined with numerical models to assess methane hydrate stability in space and time. Researchers also integrate regional coring and biological data with methane hydrate stability models to place further constraints on hydrate dynamics.

PROGRESS AND RESULTS

1. Cruise Preparation

Nearly all of Quarter #3 was spent on cruise preparation, logistics, contracting, and travel for the upcoming Fall 2016 heat flow study in the Arctic. Below we outline key milestones and achievements associated with the upcoming cruise.

1.1 Contracting (COMPLETED).

In mid-June we signed a finalized contract with Olgoonik Fairweather, the primary stakeholder of the *MV Norseman II*. The contract ensures that we sail out of Prudhoe Bay on September 12th for a 10 day cruise, returning to Prudhoe by the 21st. The contract for the ship was within budget ($300,209.60), and also covers important shipping and freight costs to get equipment to Prudhoe Bay (which is not logistically easy, but Olgoonik Fairweather have special contracts in place with pilots who can supply and guarantee freight to Prudhoe by a specific date—a key caveat). The contract includes reduced costs because of transit cost sharing between three other cruises that the *Norseman II* is conducting with other clients. The contract allows for 3 SMU researchers and 3 OSU researchers to sail. Currently we have slated Hornbach, and two graduate students for the cruise from SMU, and Harris, Phrampus, and an additional OSU researcher slated as well.

2.2 Timing and Port Calls

The cruise timing has now been finalized for September 10th, 2016-September 21nd, 2016. Importantly, this schedule is after the Bowhead whale migration and is also the period

where the lowest ice flows exist in the Beaufort. Our hope was to secure a mid-September date to minimize all potential conflicts with indigenous community whaling activities while minimizing risk of HF site access due to significant ice-flows. We are therefore very pleased with the proposed time window which avoids both whaling and significant ice windows. Additionally, we have secured port calls to and from Prudhoe Bay in the Beaufort Sea, where we will be ferried to the vessel—this saves us substantial time as it ensures virtually no time lost in transit from distant deepwater ports such as Nome, Anchorage, or Seward.

2.3 Heat Flow Equipment preparation and Shipping

The NSF-supported Heat Flow Probe Facility housed at Oregon State University has been planned for shipment to Prudhoe Bay. This equipment collected data in New Zealand in June, and at Yellowstone national park in July. Because of its heavy use and tight time window for shipment, we have scheduled to have the probe shipped directly to Prudhoe Bay via aircraft following equipment checks at Oregon State. To ensure we have quality depth readings for the heat flow probe, we have rented from the University of a very small, low power, 12 kHz pinger that we can attach to heat flow cable that will allow us to determine probe depth. Additionally, SMU has purchased a Knudsen 12 kHz listening device that will arrive at SMU the first week of August. This system will be tested at SMU and then shipped to Prudhoe Bay in a week. A study of a previous pinger system in June indicated that it would not be able to detect the heat flow probe at depths greater than 4 kHz, so SMU purchased a new recording device to ensure the system would function completely while at sea. Furthermore, SMU has purchased 10 autonomous temperature probes that we will connect to the heat flow probe cable to allow us to constrain ocean temperature with depth across the region.

2.4 Cruise transect line planning

Only minor changes to the transect lines have been made, however, we suspect that there will be more changes in the future depending on ice conditions and timing changes associated with temperature probe deployment. We have proposed a total of 50 heat flow station sites on 8 different transects that overlap 1977 seismic data collected in the Beaufort Sea. Water depths for each station range from 100-1500 mbsl. The transects extend approximately north-south from the US-Canada maritime border to Barrow, Alaska. If requested, we would be glad to provide a copy of the proposed transects. The plan is admittedly ambitious, and if achieved, would represent a huge step forward in our understanding of Arctic ocean heat flow since currently, no single publically available heat flow measurement in the Beaufort Sea exists.

2.5 Personnel

To keep cruise costs within budget, the total science party has been limited to 6. This includes three researchers from Oregon State University and 3 researchers from SMU. All scientists will likely work 12 hour shifts. SMU research include Hornbach, and two graduate students (Casey Brokaw, and Maddie Jones). OSU researchers include Post-Doc Ben Phrampus, Professor Rob Harris, and a graduate students to be named later.

2.6 Additional Safety Planning

All personnel are required to take cold-water safety training. So far, we have had one of the shipboard scientists (Ben Phrampus) take the cold water safety training class. All other scientists at SMU an OSU are scheduled to take this training in August, 2016. Rob Harris will take it at the University of Washington on August 15th. SMU researchers will take it August 6th, in Houston Texas.

3. SMU Atlantic Margin Research progress:

3.1 Pore Pressure Analysis

SMU researchers continue analyzing pore fluid pressures on the Atlantic Margin using AVO techniques. The goal of this approach is to decipher how changes in AVO response indicate changes in sediment strength, and in particular, changes in pore-fluid pressure. The past quarter has involved continued calibration of AVO pressure responses associated with methane hydrate and free gas changes in the subsurface with in-situ pore pressure measurements at Blake Ridge. This work is ongoing, but has been made less of a priority during the past two months, with cruise logistics becoming a top priority.

3.2 Western Atlantic Heat Flow Analysis

The manuscript we submitted on this topic at *Marine and Petroleum Geology* is still not through review. It has been in review for several months so we anticipate a response shortly. The results demonstrate not only where methane hydrates are located and destabilizing, but also where subsurface temperatures are likely conducive to hydrocarbon formation along the western Atlantic margin.

3.3 Recent Presentations/Publications

Presentation--Power Plays: Geothermal Energy in oil and Gas fields, Dallas Texas, April 26th, 2016"An overview of on-going and upcoming research at SMU's Geothermal Laboratory" --invited talk, Matt Hornbach

Publication: Marine and Petroleum Geology, in Revision."Thermal Evolution of the Western North Atlantic Margin: Implications for Hydrocarbon Formation" --Lead author is Ben Phrampus, formerly SMU, now post-doc at OSU, supported by this grant.

3.4 Student's supported

The project has now supported 4 students from SMU, 1 student from OSU, and a post-doc at OSU.

Students from SMU include:

Ben Phrampus (who completed his Ph.D this spring, and is now working at OSU as a post-doc, completing this project).

Vashan Wright, a Ph.D student at SMU, who has helped test and prepare sonar listening gear for the cruise.

Casey Brokaw, a Master's student at SMU, who has been working to integrate regional land-based Heat flow datasets in the Arctic with what we find offshore.

Madeline Jones, a new Ph.D student at SMU, who will sail in September on the cruise and will integrate both the heat flow with the ocean bottom temperature data to help constrain hydrate stability.

USGS Progress Report –

--only ~9k in funds for the OSU subcontract for Atlantic work remain. I have spoken with Rick Colwell about this, and we appear to be in agreement on this.

COST STATUS

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

--Total spent/encumbered for OSU subcontracting for research/personnel to date: ~$214,039
--It should be noted that OSU funds left for the subcontract on Atlantic work is ~9k.

--Total funds spent by SMU on research time/support to date:~$82,692
(SMU is currently in a no-cost extension)

--Total funds spent for subcontract for the R/V Sharp and associated ship costs: ~$227,000

--Total expended funds proposed for the *M/V Norseman II:* ~$300,000

PROBLEMS OR DELAYS

--None. The contract is signed, and we are nearly ready to go. We have solved the pinger issue associated with listening to the heat flow probe on the seafloor, and this is a significant relief.

CONCLUSIONS AND FUTURE DIRECTIONS

We remain on schedule with research, ship scheduling, and data analysis. After 3.5 years, we look forward to collecting the first ever heat flow dataset in the US Beaufort Sea!!!!

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