Oil & Natural Gas Technology

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Quarterly Progress Report
(Period ending March 31st, 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 #2, preliminary pore pressure results were presented at the 2016 Gordon Research Conference in Galveston, Texas. 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 re-

search 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

The vast majority of Quarter #2 was spent on cruise preparation, logistics, contracting, and travel for the upcoming Fall 2016 heat flow study in the Arctic. Much of what has been accomplished this past quarter is the direct result of multiple conference calls, email communications, contract negotiations between legal and grants and contracts, as well as some travel between institutions, including between SMU/OSU and the University of Washington. Below we outline key milestones and achievements associated with the upcoming cruise.

1.1 Contracting

During the past quarter, SMU has been working closely with Olgoonik Fairweather, the primary stakeholder of the *MV Norseman II*, to finalize contract negotiations. We have now had three contract versions circulated. Initially, there were several concerns regarding liability and insurance of both equipment and personnel on board. These concerns have now been alleviated and SMU's legal counsel has approved the current version of the contract. Currently, the contract is now in review at SMU's grants and contracts office. The bottom line for the contract is $300,209.60; consistent with our proposed budget. We anticipate the contract being completed by Quarter #3, likely in the next few weeks. The contract includes reduced costs because of transit cost sharing between three other cruises that the *Norseman II* is conducting with other clients. If other cruise contracts are added, our costs will be reduced further.

2.2 Timing and Port Calls

The Cruise is currently scheduled for September 12th, 2016-September 22nd, 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 that we will use for the Beaufort Sea cruise will be collecting data in New Zealand in June, and Yellowstone 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 been in negotiations with the University of Washington in Seattle to rent a very small, low power, 12 kHz pinger that we can attach to heat flow cable that will allow us to determine probe depth. During this quarter, we tested this pinger system at the UW dock to determine whether good communication would exist between ship-based hydrophones and the heat flow probe. Our analysis indicates the probe is detectable from the ship to a depth of approximately 200 m, which is currently not sufficient for some of the deepest target seafloor depths we hope to use the probe. As a result, we are likely to purchase or rent in the near future a 12 kHz hydrophone system capable of detecting deep-water pinger pulses. We are currently in discussions with UW to see what might be available for use, including different pulse frequencies, pulse amplitudes, and receiver settings. They have a significant number of possible solutions.

2.4 Cruise transect line planning

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 5. This includes two researchers from Oregon State University and 3 researchers from SMU. All scientists will likely work 12 hour shifts.

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.

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.

3.2 Western Atlantic Heat Flow Analysis

Our manuscript that analyzes hydrate stability, BSR locations, and heat flow evolution on the western Atlantic margin is currently in review at *Marine and Petroleum Geology*. 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

Hornbach gave an invited hour-long talk on pore pressure analysis and methane hydrate stability at a Gordon Research Conference in Galveston, Texas, on March 29th, 2016. The title of the talk was *"Methane Hydrates and Slope Failure on the U.S. East Coast: After 40 Years, What Have We Learned and What's Next?"* During the talk, project research and DOE funding support was prominently noted and discussed.

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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

--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 significant. We are still working on pinger communications between the heat flow probe and the ship, as noted above, but we have made significant progress and multiple options exist at UW to solve it.

CONCLUSIONS AND FUTURE DIRECTIONS

We remain on schedule with research, ship scheduling, and data analysis. Much of the next quarter's focus is finalizing all cruise plans, shipping, and safety preparations to ensure that the September 2016 cruise is a success. With this in mind, we expect the next quarterly report to be focused on final cruise logistics and probably less on research results.

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