Oil & Natural Gas Technology

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Quarterly Progress Report
(Period ending June 30th, 2015)

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 3nd quarter of FY2015 research focused on (1) finalizing the expanded SOW, budget, and Atlantic Margin cruise for September 2015, (2) circulation/editing of a draft manuscript assessing Atlantic Margin heat flow, (3) presentation of preliminary Atlantic Margin heat flow results at recent heat flow conference, (4) completion of a pre-stack depth migration image for the western Atlantic Margin that we will use for numerical modeling. With the revised statement of work completed, SMU was granted an additional $368,898 in funds to offset the cost of the 2015 fall cruise as well as costs for heat flow equipment and personnel for the Arctic in 2016. Ship contracting is underway for the R/V sharp. Approximately $227,000 is scheduled to be transferred in July to the University of Delaware to cover ship subcontracting costs. SMU researchers have been circulating and revising their draft manuscript that will be submitted to *The Journal of Marine and Petroleum Geology* assessing western Atlantic heat flow and hydrocarbon maturation. Hornbach presented results from this study in May at a geothermal conference held in Dallas, Texas. Hornbach and Phrampus continue to analyze high resolution heat flow data along the western North American margin, and, working with colleagues at Columbia, have created pre-stack time/depth migrated images showing dynamic methane hydrate stability zones along a very broad swath of the Atlantic Margin. The SMU researchers continue to analyze these data and are approximately half-way through the modeling phase of this study.

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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 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

Atlantic cruise preparation and progress:
The SOW has now been revised so that it incorporates not only the Alaska component, but also the Atlantic component of heat flow and methane hydrate stability analysis. This component of the project will be lead and run entirely by the USGS. For this component of the research, the R/V Sharp has been reserved for a September 2015 cruise as the research platform for collecting all heat flow, biogeochemical, and shallower water seismic data. The subcontract for this cruise totals ~$227,000, and SMU and the University of Delaware are now in the final phase of completing this transaction, which is currently being reviewed by SMU legal affairs. We anticipate that the contract will be finalized and signed by SMU by the week of July 7th. During this time, the USGS and OSU have been preparing steadily for this cruise for the past two months, compiling and shipping equipment and supplies (some of which was already on the loading dock because USGS personnel have a series of cruises scheduled on the Sharp this year). Currently, the cruise preparations appear to be moving forward seamlessly, and we see no major problems or delays associated with this cruise.

SMU Atlantic Margin Research progress:
SMU researchers continue to analyze seismic data and model heat flow and methane hydrate stability on the U.S. Atlantic Margin. The progress and results of this work can be broken down into three components:

(1) Circulation and editing of a draft manuscript. A paper written by the SMU research group (with graduate student Ben Phrampus as lead author) has been circulated to co-authors for review. The paper provides the first 3D heat flow model and geothermal evolution of

the western Atlantic Margin. Results show that heat flow on the margin is low, but increases seaward, and that hydrocarbon maturation occurs at depths of ~2km below the seafloor along the margin edge, consistent with seismic interpretations of source rock and thermogenic gas formation indicated in seismic data. We anticipate this work will be submitted to the *Journal of Marine and Petroleum Geology* this summer.

(2) Detailed analysis of methane hydrate instability along the Atlantic Margin between Cape Fear and Cape Lookout Slide. Hornbach and Phrampus, working with researchers at Columbia (LDEO), have created the first high-resolution MCS pre-stack time/depth migrated imaged of methane hydrate instability along the eastern North Atlantic margin. Images suggest that hydrate are destabilizing along a large zone of the margin edge (tens of kilometers) and that ocean temperature changes are the likely cause. Most surprisingly, perhaps, the images indicate that hydrate dissociation has been slowed by the fact that high concentrations of methane hydrate exist in the subsurface. When hydrate dissociates, it cools the subsurface via endothermic processes, and as a result, our analysis suggests that there has been a significant delay in methane hydrate release due to hydrate dissociation. Models are still preliminary, however, the anlysis of model results suggest that signficant quantities of methane hydrate will likely dissociate in the coming centuries. It is important to stress that this work is still very preliminary, and significantly more detailed modeling is necessary to draw firm conclusions. We continue working on this research and our hope is that we have firm conclusions by the end of the year.

(3) Results of SMU's detailed eastern North American margin heat flow analysis (in preparation for submission to the *Journal of Marine and Petroleum Geology*) were presented in May, 2015 at a geothermal conference held in Dallas, Texas. Attendance for the presentation was large and generated significant interest. The reference for this presentation is listed below:

Phrampus, B., Hornbach, M., Shillington D., Becel, A., Magnani, M.B., Hill, J., Sawyer, D. and the ENAM seismic community experiment group, "A preliminary analysis of heat flow along the US Eastern Margin using ENAM community seismic experiment data", *Power Plays: Geothermal energy in oil and gas fields*, SMU Geothermal Energy Conference, May 20th, 2015

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: ~$166,000

--Total funds spend/encumbered by SMU on research time/support to date:~$121,000
(SMU is currently in a no-cost extension)

--Total funds encumbered for subcontract for the R/V Sharp: ~$227,000

PROBLEMS OR DELAYS

--None

CONCLUSIONS AND FUTURE DIRECTIONS

Our hope is that by the next quarterly report, we will have new data from the Atlantic, our paper on Atlantic margin heat flow in review (or accepted) a paper on hydrate stability along the US east coast in development, and several additional research papers in the works related to our recent successes on the September cruise.

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