Oil & Natural Gas Technology

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Quarterly Progress Report

(Period ending September 30th, 2014)

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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ABSTRACT

FY2014 4th quarter research associated with the DE-FE0010180 grant ended with focus on expanding the scope of the study into not only the Arctic but Atlantic Ocean. During the 4th quarter, we spent much of the time working through logistics of developing an Atlantic field campaign for summer/fall 2015. A publication on arctic methane hydrate stability has been accepted pending minor revisions in the Journal of Geophysical Research, however, only limited progress was made on numerical modeling research of methane hydrate stability in the arctic primarily because no clear BSRs are observed in the limit number of sparker profiles collected in the Beaufort during 2012. There is the possibility that additional sparker data may contain BSRs but currently this is unclear as these data apparently require further processing. We have agreed to a no-cost extension for the project and will use the 1st quarter of FY2015 to reassess the timing, scope, and scale of Atlantic and Arctic operations.

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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 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 the Alaskan Margin. To accomplish these goals, we will use geophysical (seismic, heat flow, CTD/XBT) data combined with numerical models to assess methane hydrate stability in space and time. We will also integrate regional coring and biological data with methane hydrate stability models to place further constraints on hydrate dynamics.

PROGRESS AND RESULTS

SMU Progress on hydrate stability analysis in the arctic:

The goal of SMU's numerical modeling study is to determine (1) regional heat flow and methane hydrate stability along the upper Beaufort margin using seismic data first collected in 1977, (2) compare the zone of methane hydrate stability with predicted locations of methane hydrate stability based on ocean temperature measurements, and (3) compare the location of methane hydrate stability in 1977 with 2012 seismic data to determine potential rates of destabilization along the margin. We have completed the first two objectives, and the results of this are now included in a paper soon to go to press in the Journal of Geophysical Research—Solid Earth. The key result of our study is that it shows the arctic ocean is warming rapidly and that the methane hydrate stability zone in 1977 was not in equilibrium. Specifically, the BSR was too deep, implying that hydrate destabilization occurs along the upper margin of the Beaufort Sea.

Although a goal of this research is to address how methane hydrate stability has changed between 1977 and 2012. This analysis is currently not feasible. To date, we have only a limited number of USGS sparker data that were collected in the vicinity of the 1977 seismic lines, and looking at the processed data provided, it is not entirely clear that a BSR exists in this dataset for comparison. Whether additional sparker data show BSRs is unclear. From presentations we have seen using some of the sparker data, there appears to be some evidence for BSRs in the deeper environment but not necessarily on the margin. Further access and processing of sparker data at the USGS may provide additional insight, but we will not know for sure until the data are processed and released. Even if these data do show BSRs, our understanding is that these other lines are apparently not collected directly over 1977 data lines so they will be of limited value, and will at the very least require significant interpolation of BSR depth across the region, if such interpolation is even possible. This result implies that perhaps the only clear way we will be able to place estimates on rates of methane hydrate destabilization during the past 35 years will be through (1) high resolution heat flow measurements integrated with the models and (2) access to additional regional seismic data collected over the site. Ultimately, heat flow values acquired during the upcoming arctic research cruise will provide valuable insight by yielding temperature depth profiles that can help decipher where non-steady state subsurface temperature conditions exist. Nonetheless, to estimate long-term bottom temperature changes, we will need to analyze both regional heatflow and regional bottom water temperature changes across the site and compare to regional BSRs. Assuming no other useful seismic data are made available, we will be heavily dependent on the heat flow data acquired from the upcoming cruise to make more progress and place new constraints on regional hydrate stability changes with time.

USGS progress on ship scheduling:

During the past quarter, the USGS has taken the lead on determining what ships might be available both in the Arctic and Atlantic for summer/fall 2015 and 2016. The general consensus is that it will be significantly easier to schedule a ship in the Atlantic for summer/fall 2015. As a result, we will focus our efforts on the Atlantic for 2015, and work towards finding a ship of opportunity for the Arctic for 2016. We currently have a requested use of the R/V Sharp for ~17 days next fall.

COST STATUS

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

--Subcontract to OSU for research support and cruise preparation:$7562

--Overhead: ~$1512.

Total approximate expenditures charged to DOE on SMU Grant in Quarter #4: ~$9074

PROBLEMS OR DELAYS

--multi-year analysis of methane hydrate stability using seismic data from 1977 to 2012 is currently impossible due to the lack of BSRs in 2012 sparker seismic line provided. It’s possible that other 2012 seismic lines have better quality BSRs for comparison, but these lines were ap-

parently not collected coincident with 1977 data, making it difficult to compare. SMU currently does not have access to the additional 2012 seismic lines where other BSRs might exist, and our understanding is that they are still being processed, but it is not yet clear if they will add value to the time dependent study.
--it remains unclear how we will pay for both the Atlantic and Arctic cruises if we wish to complete all of the proposed objectives at each site location. I estimate that if we intend to collect core and heatflow for both the Arctic and Atlantic programs, the additional expense will approach $1 million dollars due to increased ship costs now required for arctic work and the need to replenish personnel and equipment costs for a full coring/heat-flow arctic study in 2016. This large additional cost is due in part to the significant funds we will expend at SMU and the USGS to conduct the work in the Atlantic (including ship costs). Alternatively, if we keep the coring/heat flow work more limited to a single area like the Atlantic, and conduct only heat flow analysis in the arctic using a pogo probe, I anticipate the increase in cost will be significantly less (on the order of $200,000-400,000) due to reduced ship spec requirements for a pogo probe and less equipment and personnel needs to collect the data. The obvious trade-off is that we would only collect significant geochemical/coring data in the Atlantic and not the arctic. Nonetheless, given that the Atlantic cruise will result in (1) reduced ship cost (and greater ship time), (2) easier sediment penetration (less compacted sediment compared to arctic), and (3) data collection at several well constrained seep targets, I believe the coring objectives are likely easier to achieve on the Atlantic, so taking a more limited approach in the arctic may be acceptable. Further discussion with DOE is warranted regarding what approach makes the most scientific and financial sense.

CONCLUSIONS AND FUTURE DIRECTIONS

We continue to work through the logistics for possible upcoming cruises in both the Atlantic and Arctic. We will use the next quarter to secure possible vessels and further develop an expanded SOW for the study, incorporating Atlantic margin objectives. Future modeling work in the arctic will likely be on hold until either more data are collected or made available.

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