

# Oil & Natural Gas Technology

DOE Award No.: DE-NT0005667

## Quarterly Progress Report

April 2012 – June 2012

### ASSESSING THE EFFICACY OF THE AEROBIC METHANOTROPHIC BIOFIL- TER IN METHANE HYDRATE ENVIRONMENTS

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## **EXECUTIVE SUMMARY**

In October 2008 the University of California at Santa Barbara (UCSB) initiated investigations of water column methane oxidation in methane hydrate environments, through a project funded by the National Energy Technology Laboratory (NETL) entitled: assessing the efficacy of the aerobic methanotrophic biofilter in methane hydrate environments. The fifteenth quarter of this project was dedicated to the preparation and revision of four manuscripts describing methane oxidation in environments ranging from benthic microbial mats to suboxic basins to the open ocean.

During this period project personnel submitted one manuscript to Limnology and Oceanography (Pack et al.) in revised form, and continued with the preparation of four other manuscripts. The works in preparation include studies of methanotrophy in microbial mats, Arctic lakes, the Gulf of Mexico and suboxic marine basins. Each of these manuscripts has been drafted and each is presently being edited by coauthors.

## **PROGRESS, RESULTS AND DISCUSSION**

### **Task 1 - Project Management Plan (PMP)**

*This task was completed during the first quarter of this award.*

### **Task 2 - Field Sampling of Microbial Mats**

#### **Subtask 2.1 - Coal Oil Point Sampling**

#### **Subtask 2.2 - Santa Monica Basin Sampling**

*Task 2 was completed during a previous reporting period.*

### **Task 3 - Turnover Rates for Methane Oxidation in Microbial Mats**

#### **Subtask 3.1 - Turnover Rates for Coal Oil Point Samples**

#### **Subtask 3.2 - Turnover Rates for Santa Monica Basin Samples**

*Task 3 was completed during a previous reporting period.*

### **Task 4 - Molecular Analyses of Methanotrophs**

We continue to prepare a manuscript describing the methane oxidizing gene distribution during the bloom that occurred following the Deepwater Horizon event. The approach for this work is finalized as are the data, though emerging technologies promise to improve our ability to analyze methanotrophs at the molecular level. This task is now considered complete.

### **Task 5 - Stable Isotope Probing**

#### **Subtask 5.1 - Stable Isotope Probing of Coal Oil Point Samples**

#### **Subtask 5.2 - Stable Isotope Probing of Santa Monica Basin Samples**

#### **Subtask 5.3 - Stable Isotope Probing of Gulf of Mexico Water Samples**

*Task 5 was completed in a previous reporting period.*

### **Task 6 - Field Measurements in the Santa Barbara Basin**

#### **Subtask 6.1 - Shallow Water Sampling and Measurements, Santa Barbara Basin**

#### **Subtask 6.2 - Deep and Bottom Water Sampling and Measurements, Santa Barbara Basin**

#### **Subtask 6.3 - Repeat Sampling, Santa Barbara Basin**

*Task 6 was completed in a previous reporting period.*

### **Task 7 – Analysis of Methane Oxidation Rates and Methane Turnover Times Throughout the Santa Barbara Basin**

#### **Subtask 7.1 - Shallow Water**

#### **Subtask 7.2 - Interior Water**

#### **Subtask 7.3 –Targeted Measurements**

*Task 7 was completed in a previous reporting period.*

### **Task 8 - Analysis of Current Velocity Data**

#### **Subtask 8.1 – Current Velocity Analysis for the Shallow Santa Barbara Basin**

### **Subtask 8.2 - Current Velocity Analysis for the Deep Santa Barbara Basin**

*Task 8 was completed in a previous reporting period*

### **Task 9 - Development of a methane budget for the Santa Barbara Basin**

We have completed a draft methane budget for the Santa Barbara Basin and are beginning the process of developing a corresponding manuscript. This task is now considered complete.

### **Task 10 - Field Sampling of Waters**

#### **Subtask 10.1 - Santa Barbara Basin Water Sampling**

#### **Subtask 10.2 - Southern California Margin Water Sampling**

#### **Subtask 10.3 - Targeted Water Sampling**

#### **Subtask 10.4 – Gulf of Mexico Water Sampling**

This task was completed in a previous reporting period.

### **Task 11 - Sensitivity Testing of Methane Oxidation Rates**

This task was completed during a previous reporting period.

Project personnel focused their primary efforts on data analysis and manuscript preparation and submission of revisions. We further analyzed samples using single cell genomics to address questions of methanotrophic ecology which has proven to be quite promising as a future approach but will not be applied here because the award is coming to conclusion.

### **Conclusion**

The current period saw the continued analysis of data the submission of one manuscript in revised form and the continued preparation of four manuscripts papers. These efforts represent our continued transition toward data analysis and publication as this award draws to a close.

# COST STATUS

There are no subcontracts to this award. All funds are being expended by UCSB. Financial report under separate cover.

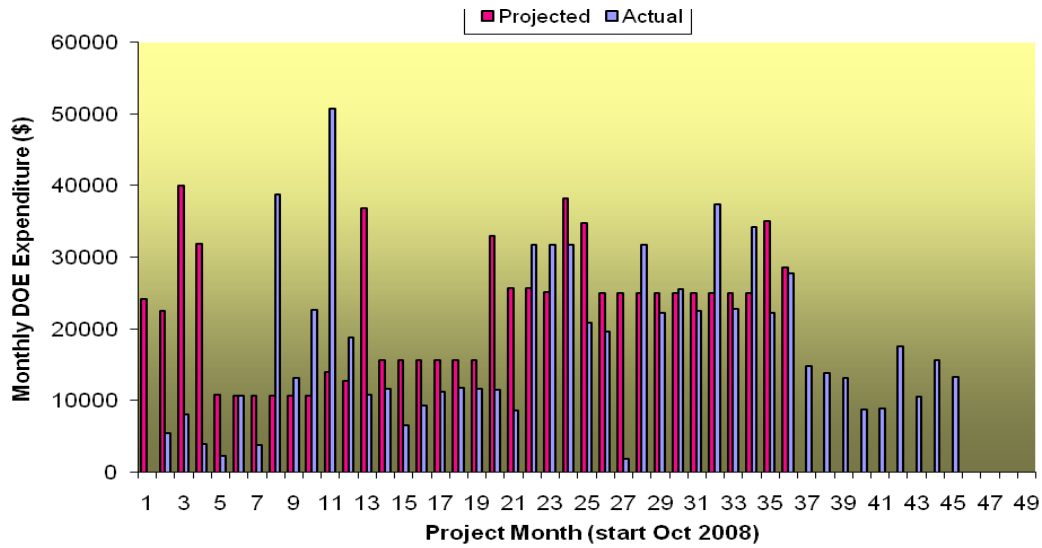


Figure 1. Project costing profile

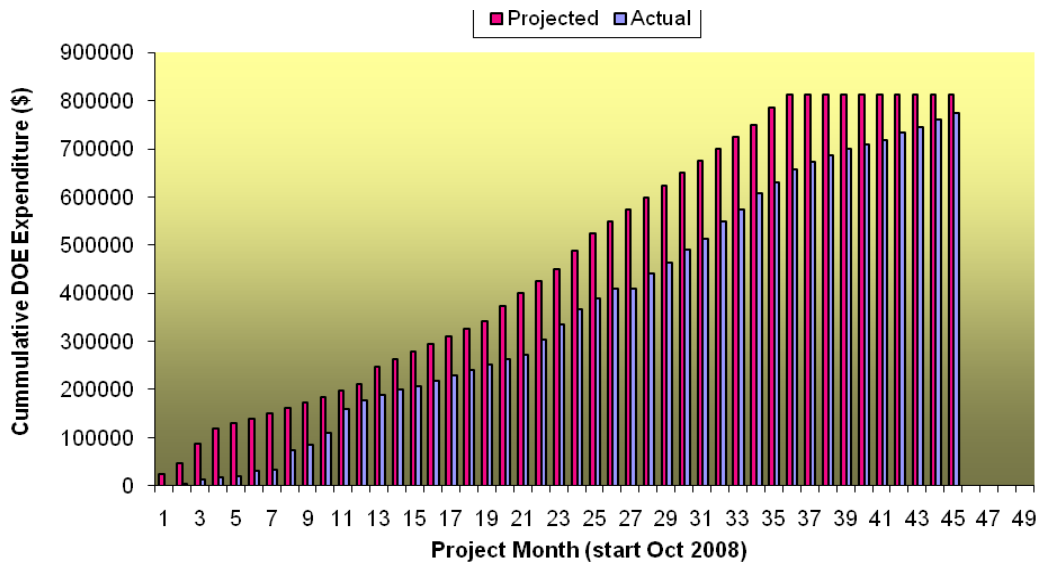


Figure 2. Project cumulative costs

## MILESTONE STATUS

*Milestone 1:* Successful installation and sea trial of the CTD rosette system and ADCP. This milestone relates closely to Tasks 6.1, 6.3, 10.1, and 10.3, and must be reached to enable sampling in support of tasks 7.1, 7.3, 8.1, and 11. The estimated completion date for this milestone is 4/1/09, but may be pushed back until June/July, 2009 on account of missing the fall, 2008 weather window.

Status: This milestone was completed during a previous reporting period.

*Milestone 2:* Confirmation of  $^3\text{H-CH}_4$  oxidation and  $^{13}\text{C-CH}_4$  uptake by benthic microbial mats from Coal Oil Point seeps. This milestone relates directly to Tasks 2.1, 3.1, and 5.1 and will further facilitate the completion of tasks 4, and 5.2. The estimated completion date for this milestone is 7/1/09.

Status: This milestone was completed during a previous reporting period.

*Milestone 3:* Completion of the SEEPS 09 cruise. The SEEPS 09 cruise presents an unrivaled level of access to recently discovered methane hydrate sites in the Santa Monica Basin and to water column sites throughout the Southern California margin including the deep Santa Barbara Basin. The cruise and associated sampling relate closely to Tasks 2.2, 6.2, and 10.2, and will facilitate completion of tasks 3.2, 4, 5.2, 8.2, 9, and 11. The estimated completion date for this milestone is 1/1/10, but the timing will necessarily depend on the UNOLS scheduling of this (already approved) cruise.

Status: This milestone was completed during a previous reporting period.

*Milestone 4:* Completion of the Gulf of Mexico (GoM) cruise. The GoM cruise presents an unprecedented opportunity to track the fate of methane from a massive methane plume. During this cruise aboard the *R/V Cape Hatteras* samples will be collected for methane concentration, methane oxidation rates, methane stable isotopes, microbial cells, and large volume filtrates for DNA. The estimated completion of this milestone is 6/30/10 and is associated with tasks 5.3 and 10.4.

Status: This milestone was completed during a previous reporting period.

*Milestone 5:* Complete a preliminary analysis of current velocity data and oxidation rate data from the SEEPS 09 cruise. This milestone must be achieved to address Tasks 6.3, 7.3 and 11. The estimated completion date for this milestone is 10/1/10.

Status: This milestone was completed during a previous reporting period.

*Milestone 6:* Conduct a preliminary analysis for *mmo* and 16S rRNA gene sequences for putative methanotrophs from the Santa Monica Basin, and compare to se-

quences from Coal Oil Point seeps. This milestone relates directly to Tasks 4, 5.1, and 5.2, and will determine the approach taken in completing Tasks 4 and 5. The estimated completion date for this milestone is 12/1/10.

Status: This milestone was completed during a previous reporting period.

*Milestone 7:* Complete the ocean-going sampling program, and perform preliminary analysis of all physical and chemical data to ensure sufficient data for further analysis. This milestone relates directly to Tasks 6.3, 7.3, and 10.3 and will facilitate the completion of Tasks 9 and 11. The estimated completion date for this milestone is 4/1/11.

Status: This milestone was completed during a previous reporting period.

## ACCOMPLISHMENTS

→ The manuscript submitted to *Limnology and Oceanography* (Pack et al) was conditionally accepted, and submitted in revised form.

## PROBLEMS OR DELAYS

None

## PRODUCTS

→ Fourteenth Quarterly Report Submitted

→ **Submitted in revised form: Pack MA, MB Heintz, WS Reeburgh, SE Trumbore, DL Valentine, X Xu, ERM Druffel (submitted in revised form) Methane oxidation in the eastern tropical north Pacific water column. *Limnology and Oceanography*.**

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