Quarterly Report

PROPERTIES OF SEDIMENTS CONTAINING METHANE HYDRATE, WATER, AND GAS SUBJECTED TO CHANGING GAS COMPOSITIONS

Period Covering July 1, 2013 – September 30, 2013
Submitted October 31, 2013

WORK PERFORMED UNDER

ESD12-011

SUBMITTED BY

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INTRODUCTION

The objective of this work is to measure physical, chemical, mechanical, and hydrologic property changes in sediments containing methane hydrate, water, and gas subjected to injection of carbon dioxide and nitrogen. Because the replacement of methane by carbon dioxide and nitrogen is thermodynamically favored in some cases, these gases are considered to enhance the extraction of methane from hydrate, and to simultaneously sequester carbon dioxide. DOE has participated in a field test in Alaska in which nitrogen and carbon dioxide were introduced into a reservoir containing methane hydrate, water, and gas, and then gas was extracted. Analysis and modeling of the data and processes observed are expected to be performed for some time resulting in questions that can be efficiently answered in the laboratory. We propose to make measurements that will support these investigations. We will share our results with those analyzing the field test, and the scientific community, and communicate with those analyzing the field test to ensure our tests are on target to answer their questions.

Studies performed to date have examined basic thermodynamic and methane hydrate structural changes upon introduction of other hydrate forming molecules showing that carbon dioxide tends to replace methane in large cages ideally resulting in about 64% methane replacement, and nitrogen replaces methane in small cages resulting in an additional 21% replacement. Few studies have been performed to examine changes to the physical, mechanical, and hydrological properties of hydrate-bearing sediments undergoing gas exchange. Laboratory tests examining methane replacement by mixed nitrogen/carbon dioxide in a porous medium containing methane hydrate, water, and methane gas have not yet been performed.

CURRENT TASKS AND PROGRESS:

Task 5.0 Measurement of kinetics of gas exchange in a hydrate/water/gas system

Title: Complete measurements of gas exchange and hydrologic properties of media containing methane hydrate, water, and gas subjected to N_2/CO_2 gas flooding.
Planned Date: December 31, 2013
Verification Method: Internal review and analysis of data set.

Progress:
To date, three experimental runs of this gas exchange have been completed and compared to measurement of gas exchange with hydrate in the column and no liquid water. The three runs represent technical replicates. In the replicates with water present, less methane was eluted from the sample and the exchange rates are on the order of a order of magnitude lower than the “dry” hydrate (with water present, on the order of $4x10^{-8}$ moles methane/(mole water*s), with no water present, on the order of $2x10^{-7}$ moles methane/(mole water*s) (Note that in these rates, the moles of water refers to water originally held in the hydrate.)

Task 6.0 Investigation of mechanical and hydrologic property changes of media containing methane hydrate, water, and gas subjected to nitrogen and CO2 flushing

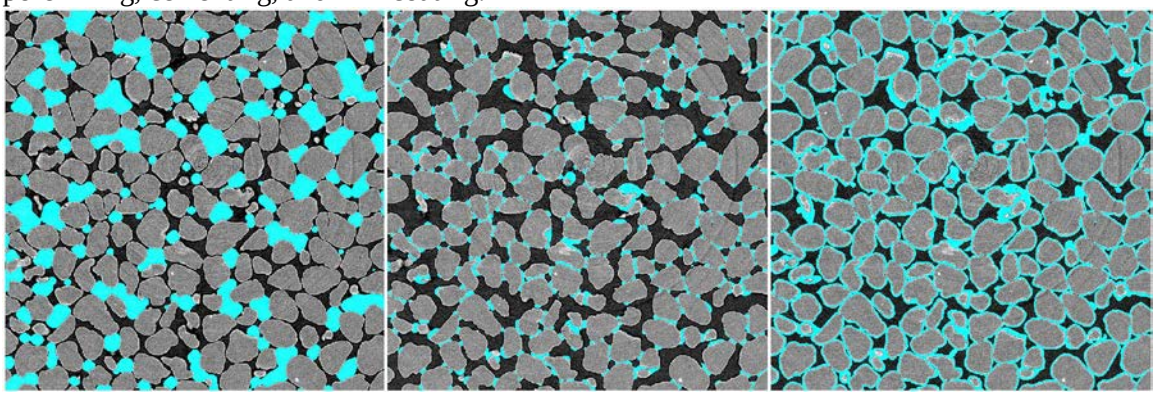
Title:	Complete geophysical measurements of media containing methane hydrate, water, and gas subjected to N_2/CO_2 gas flooding.
Planned Date:	February 28, 2014
Verification Method:	Report containing description of tests, results, and interpretation.

Progress:
Selection of experimental parameters is based on the results of Task 5. This test has not begun.

Task 7.0 Grain-scale Computation of Hydrate-Bearing Sand Properties Based on microCT Sample Description (collaboration with NETL)

Title:	Obtain Finite Element Code and perform / demonstrate code usage.
Planned Date:	February December 31, 2013
Verification Method:	Internal review of preliminary results.

Progress:
Initial synthetic applications of hydrate to X-ray microcomputed tomographic data has been performed and is being evaluated for similarity to the conceptual models to be evaluated. An example is presented below where hydrate is blue and the three models are pore filling, cementing, and film coating.



COST STATUS

Cost Plan/Status

		FY13				FY14			
Baseline Reporting Quarter		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Baseline Cost Plan									
Federal Share	Task 4				2	0	0	2	
	Task 5				17	9	9		
	Task 6					0	15	16	
	Task 7				20	10	10		
Non-FederalShare					0	0	0		
Total Planned Cost					39	19	34	18	
Federal and Non-Federal					39	19	34	18	
Cumulative Baseline Cost					39	58	92	110	
Actual Incurred Costs									
Federal Share	Task 4				2				
	Task 5				16				
	Task 6				0				
	Task 7				6				
Non-FederalShare					0				
Total Planned Cost					39				
Federal and Non-Federal					24				
Cumulative Incurred Cost					24				
Variance									
Federal Share	Task 4				0				
	Task 5				1				
	Task 6				0				
	Task 7				14				
Non-FederalShare					0				
Total Planned Cost					0				
Federal and Non-Federal					15				
Cumulative Variance					15				

Table 1. Cost plan and status for Budget Period 2.

DELIVERABLES STATUS

Include the following list of deliverables in the SOPO document:

Deliverable	Brief Description	Frequency/Schedule
Updated Project Management Plan	Provides an update of how the project will be executed, monitored, and controlled in meeting the programmatic goals and objectives. Includes a detailed discussion about risk identification, mitigation and management.	Due 30 days **after any major project modification**
Research Performance Progress Report	Provides a narrative assessment of the technical, milestone/schedule, and cost status of the research. Measures changes in schedule or completion status of the originally planned milestones (as set forth in the Project Management Plan) and their actual completion dates. Monitors actual costs against baseline costs provided in the Project Management Plan	On or before 30th day after each quarter
Annual Research Performance Progress Report	Full account of progress, problems encountered, significant accomplishments, and approaches to be taken the following year. Includes status of milestones/schedule and cost.	Within 60 days after end of project year
Final Technical Report	Full account of all work performed during the project period in a comprehensive manner.	Within 90 days after project ends
Topical Report (as needed)	Provide a comprehensive statement of the technical results of the work performed for a specific task or subtask or detail significant new scientific or technical advances.	Within 45 days of request
Topical Report	A report documenting the design and construction of a laboratory system allowing investigation of the kinetics of gas exchange (e.g. CO2 into methane hydrate) in hydrate-bearing sediments will be submitted.	July 31, 2012 Submitted
Topical Report	A report on the changes in hydrologic and geophysical properties of methane hydrate-bearing media subjected to nitrogen or CO2 gas flooding will be submitted.	October 31, 2012 Submitted
Topical Report	A report on the changes in hydrologic and geophysical properties of porous media containing methane hydrate, water, and gas and subjected to nitrogen or CO2 gas flooding will be submitted. See Tasks 5 and 6.	February 28, 2014 Work on track for timely submittal
Topical Report	A report documenting the results of our Grain-scale Computation of Hydrate-Bearing Sand Properties Based on microCT Sample Description (collaboration with NETL) will be submitted. See Task 7.	April 30, 2014 Work on track for timely submittal
Conference Papers/ Proceedings/ Articles	Documents include conference papers, proceedings, presentations, journal articles, and press releases.	Minimum of 7 business days prior to submission
Ad hoc photos/ illustrations/ data	Photos, illustrations, diagrams, and related research data that can be used by SCC-OCP for presentations and other program documentation	As requested