Natural Gas Hydrates Research Portfolio

Quarterly Progress Report

FY15-Q1

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Table of Contents

Acronym List

Acronym	Descriptive Name
2D	Two-Dimensional
3D	Three-Dimensional
AGH	Aqueous-Gas-Hydrate
AK-DNR	Alaskan Department of Natural Resources
ANS	Alaska North Slope
Be	Beryllium
CMU	Carnegie Mellon University
CO_2	Carbon Dioxide
CSM	Colorado School of Mines
CT	Computed Tomography
DOE	Department of Energy
DT	Sonic
FAL	Focus Area Lead
FEHM	Finite Element/Finite Volume Heat and Mass Transfer Computer Code
FWP	Field Work Proposal
GR	Gamma Ray
GUI	Graphical User Interface
HBS	Hydrate-Bearing Sediment
HQ	Headquarters
HRS	HydrateResSim
HSZ	Hydrate Stability Zone
MST	Multi-Stage Tests
NETL	National Energy Technology Laboratory
NMR	Nuclear Magnetic Resonance
ORD	Office of Research and Development
PBU	Prudhoe Bay Unit
PID	Proportional-Integral-Derivative
Pitt	University of Pittsburgh
PMP	Project Management Plan
PSIG	Pounds per Square Inch Gauge
PSU or Penn State	The Pennsylvania State University
R&D	Research and Development
Res	Resistivity
RES	Research and Engineering Services
SARS	Safety Analysis and Review System

Acronym	Descriptive Name
SCNGO	Strategic Center for Natural Gas and Oil
S_H	Hydrate Saturation
SHC	Shale Content
SMP	Spatially Mobilized Plane
SOPO	Statement of Project Objectives
SSR	Solid-State Relay
SST	Single-Stage Tests
S_W	Water Saturation
TCD	Thermal Conductivity Detector
THF	Tetrahydrofuran
THM	Thermal-hydrological-geomechanical
TM	Technology Manager
TMo	Technical Monitor
TPL	Technical Portfolio Lead
TTP	Thermal Transfer Plate
TVDSS	Total Vertical Depth
USGS	United States Geological Survey
VSHC	Volume of Shale Content
WVU	West Virginia University

1.0 Annual Executive Summary

The Annual Executive Summary will be provided in the FY15-Q4 Report.

2.0 Milestones

The status of the M-1 milestones is presented below in Table 1.

Table 1: Major Goals of the Project

Milestone Identifier	Milestone Title	Planned Completion Date	Actual/ Forecast Completion	Method of Verification	Comments
Outstanding FY14 Milestones					
M1.14.3.B	Complete data analysis for tri-axial tests and development of a constitutive model defining the relationship between hydrate saturation and elastoplastic soil behavior parameters.	09/30/2014	11/14/2014	Manuscripts on the testing program and constitutive modeling (Subtask 3.2, 09/14).	Complete
Task 2.0 Reservoir Simulation of Gas Hydrates Production Field Tests					
M1.15.2.A	Analysis of Iġnik Sikumi #1 code comparison problem for code comparison and analysis.	03/31/2015	03/31/2015	Series of manuscripts on the Iġnik Sikumi history match from the Code Comparison Group (Subtask 2.2).	Delayed due to lack of collaboration partners. Planned and Actual/Forecast Completion Dates were changed from 12/31/2014. SCNGO was notified of the change. The Planned Completion Date was rebaselined.
M1.15.2.B	Complete simulations of production and flow modeling from a long-term depressurization test at the site chosen for the field test.	06/30/2015	06/30/2015	Manuscript on depressurization test scenarios on the Alaska North Slope (Subtask 2.1).	
M1.15.2.C	Analysis of a Marine hydrate-based problem for code comparison and analysis.	09/30/2015	09/30/2015	Problem sets developed and shared with collaboration partners (Subtask 2.2).	

Milestone Identifier	Milestone Title	Planned Completion Date	Actual/ Forecast Completion	Method of Verification	Comments
Task 3.0 Laboratory Hydrologic and Geomechanical Characterization and Analysis of Hydrate-Bearing Sediments					
M1.15.3.A	Demonstration of core flow equipment and personnel capability to conduct the relative permeability test on hydrate-bearing sediments.	03/31/2015	03/31/2015	Improved mobile gas hydrate testing unit with additional gas/fluid mass flow meters and temperature chamber (Subtask 3.1).	Delayed due to lack of research supporting staff. Planned and Actual/Forecast Completion Dates were changed from 12/31/2014. SCNGO was notified of the change. The Planned Completion Date was rebaselined.
M1.15.3.B	Complete relative permeability tests on various types of sediment textures at different hydrate saturations and effective confining stresses and porosities.	03/30/2015	03/30/2015	Report on relative permeability of HBS (Subtask 3.1).	
M1.15.3.C	Complete a working TOUGH+FLAC framework.	03/30/2015	06/30/2015	A working TOUGH+FLAC code incorporated constitutive laws for hydrate-bearing soils (Subtask 3.3).	Staff has not been identified.
M1.15.3.D	Complete tri-axial geomechanical strength and deformability tests on dissociated HBS at various dissociation levels.	06/30/2015	06/30/2015	Manuscript on geomechanical strength tests on hydrate-bearing sediment under dissociation condition (Subtask 3.2).	
M1.15.3.E	Complete data analysis for tri-axial tests and development of a constitutive model.	09/30/2015	09/30/2015	Manuscripts on the geomechanical tests for HBS under hydrate dissociation condition and constitutive modeling (Subtask 3.3).	Research staff and faculty have not been identified for Subtask 3.3 associated with this milestone.

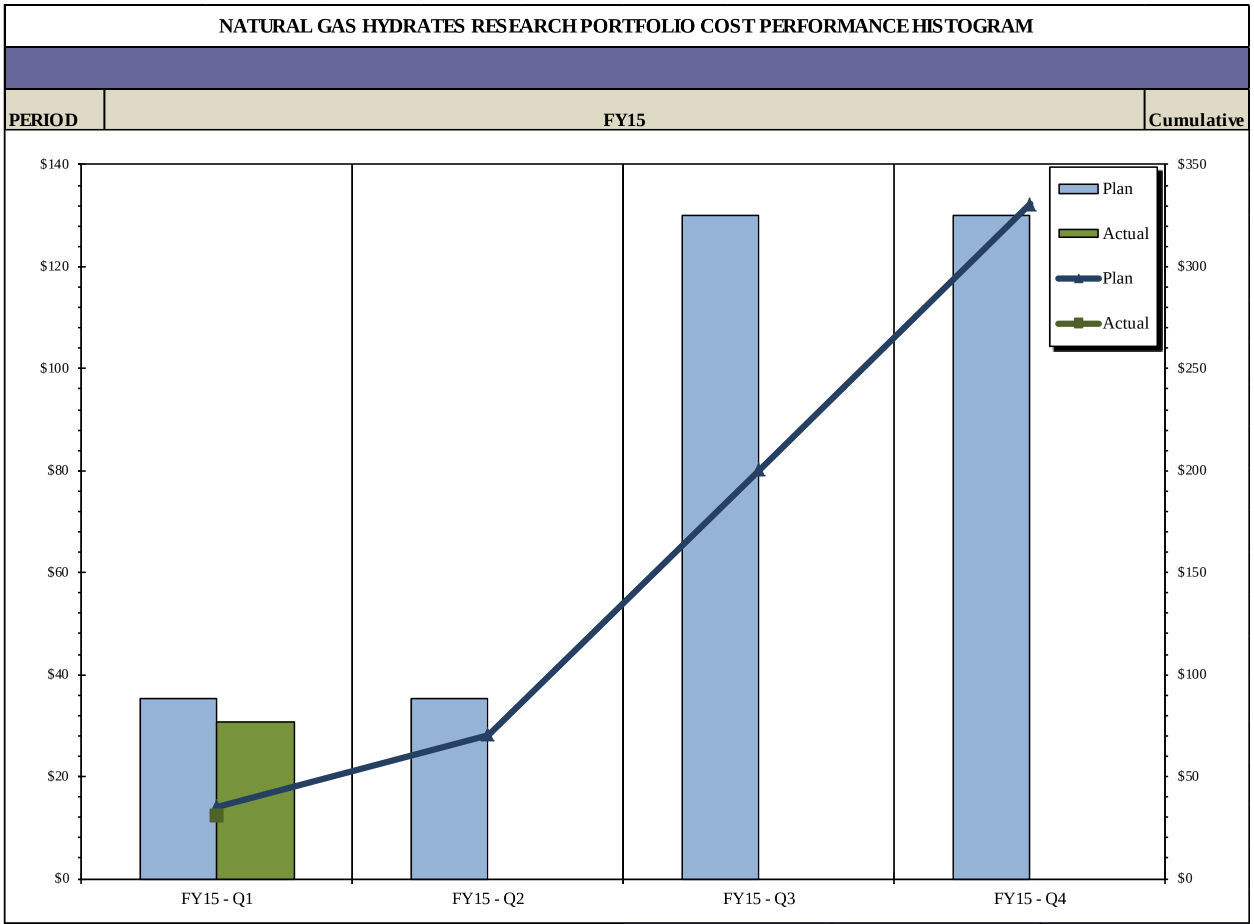
Milestone Identifier	Milestone Title	Planned Completion Date	Actual/ Forecast Completion	Method of Verification	Comments
Task 4.0 Pore-Scale Visualization and Characterization of Hydrate-Bearing Sediments					
M1.15.4.A	Complete visualization of hydrate evolutions during brine injection and validate the NETL proposed non-cementing hydrate formation method.	03/31/2015	03/31/2015	Report on hydrate evolutions during continuous saline flow and images/videos on this dynamic process (Subtask 4.1).	
M1.15.4.B	Complete design, modification, and manufacture of end pieces for current high-pressure X-ray microCT vessel to have geomechanical measurement capabilities.	06/30/2015	06/30/2015	Manuscript on understanding permeability in sediments under heterogeneous pressure distribution during hydrate dissociation (Subtask 4.2).	
M1.15.4.C	Complete X-ray micro CT imaging for water and gas distributions after hydrate dissociation and implication of flow permeability during dissociation.	09/30/2015	09/30/2015	Report on process monitoring using wave velocity and CT scanning in hydrate-bearing sediments, focusing on effects of hydrate morphology, particularly for common hydrate morphologies in nature such as patchy and veins (Subtask 4.3).	
M1.15.4.D	Development of a microfluidic, 2D system for flow and permeability determination.	09/30/2015	09/30/2015	Report on the 2D Microfluidic flow tests (Subtask 4.4).	

Note: Gray highlighting from the Hydrates FY15 FWP and FY15 PMP was removed from this quarterly progress report since funding was received and qualified researchers or students were identified for full staff support, with the exception of staffing for Subtask 3.3 associated with milestone M1.15.3.E.

3.0 FY Budgetary Information

The variance from the FY14 funding for the Natural Gas Hydrates program is funding and supporting the RES contract effort through the end of the current RES contract. No FY15 funding currently supports efforts related to the site support contract.

The cost performance histograms are provided below (Figure 1) to show the planned and actual cost performance for the Natural Gas Hydrates Research Portfolio.



	FY15 - Q1	FY15 - Q2	FY15 - Q3	FY15 - Q4	TOTAL
Period					
Plan	$35	$35	$130	$130	$331
Actual	$31				$31
Cumulative					
Plan	$35	$71	$201	$331	$331
Actual	$31				$31

Figure 1: FY15 Natural Gas Hydrates Research Portfolio cost performance histogram ($ x 1,000).

4.0 Technical Progress

Fiscal Year 2015 Quarter 1

Accomplishments

Task 1.0 Project Management and Outreach

All project management deliverables from the NETL Office of Research and Development (ORD) to the Strategic Center for Natural Gas and Oil (SCNGO) were delivered on time with support from the Project Management Office (PMO). Deliverables inclusive of reports to SCNGO, task and subtask meetings, monthly invoice reviews with AECOM/URS, and milestone tracking were all met within the scheduled timeframe. SCNGO can access their required deliverables via SharePoint at: http://prod65-share4.netl.doe.gov/sites/ORD-PMO/Pages/SCNGO.aspx.

The FY15-Q1 deliverables included:

- The FY14-Q4 Report was submitted to SCNGO on November 20, 2014.
- As per new SCNGO guidance, the progress reports for Q1, Q2, Q3, and Q4 were cumulated with an annual executive summary to serve as the annual report deliverable.

Technical writing, deliverable coordination, and project controls support were provided by the PMO.

Task 2.0 Reservoir Simulation of Gas Hydrates Production Field Tests

Subtask 2.1 Alaska North Slope Production Test Simulation Assistance

- A 3D heterogeneous Site 2 model was constructed. Site 2 is a theoretically deeper Mt. Elbert-like deposit which might be encountered within the Milne point unit. Since the reservoir depth of Site 2 is yet unknown, a series of simulations were run with a range of reservoir depths varying from 570 – 670 m. Gas rate profiles show that higher gas rates are obtained with an increase in reservoir depth. These results are reasonable because the relatively higher temperatures of deeper reservoirs increase instability of the hydrates which make them dissociate readily.
- A framework for conducting flow assurance studies in production wellbore was designed. This was done by developing a transient 2D temperature model in a two-phase vertical wellbore water+gas system with hydrate formation using the approach of computational fluid dynamics. An annulus growth of the hydrate propensity field was observed within the wellbore.
- The next steps will involve conducting sensitivity runs and uncertainty analyses on Site 2 with respect to the distribution of hydrate saturation and porosity.

The wellbore models will be refined by relaxing some of the assumptions to improve on their validity and accuracy.

Subtask 2.2 International Code Comparison Continuation – Iġnik Sikumi History Match Analysis and Marine Deposit Based on the 2013 Nankai Trough Test or Other Marine Sites

Different numerical simulation scenarios were considered with a focus on understanding the CO_2 injection into the hydrate bearing sands of the permafrost regions. The recent, primary focus is on the formations of the Prudhoe-Bay L-Pad regions.

Summary of work completed in FY14-Q4:

- Numerical simulations were done to study the migration of CO_2 in the hydrate formations of the Prudhoe Bay site. CO_2-Hydrate is more stable than CH_4-Hydrate only at lower pressures (until 285 K); therefore, the top of HSZ (Hydrate Stability Zone) of CH_4 was deeper than the top of HSZ of CO_2. The reservoir domains were considered as two different zones, Zone-1 being CH_4-CO_2 Hydrate (AGH state variable was assigned) and Zone-2 as CH_4-CO_2-Hydrate. In these simulations: (1) gaseous CO_2 was injected near the top of CH_4 HSZ at a particular pressure and temperature conditions and (2) CH_4 production well was modeled as a surface boundary nearly 50 m away from the origin. CH_4 production is achieved by depressurizing the domain. Different numerical simulations were performed by changing the state variables of Zones 1 and 2.
- The accomplishments primarily involved studying the CO_2 flow in an inclined reservoir modeling the reservoir conditions of the Prudhoe Bay L-Pad region. The trend of the pressure, temperature, and CH_4-CO_2-Hydrate compositional changes in the formations due to the injection of $CO_{2(g)}$ and $CO_{2(AqG)}$ at the top of the hydrate stability zone of CH_4 hydrate was studied.

Task 3.0 Laboratory Hydrologic and Geomechanical Characterization and Analysis of Hydrate-Bearing Sediments

Subtask 3.1 Laboratory Measurement of Relative Permeability of CH_4 Gas in Brine-Saturated Hydrate-Bearing Sediments

Relative permeability of CH_4 gas in hydrate-bearing sediments (HBS) is a key parameter for numerical simulations and is yet to be determined with relevant samples. In FY15-Q1, this task focused mainly on the planning and development of a new experimental setup to properly measure the relative permeability based on existing mobile carts.

- A literature review was conducted. Few studies, regarding "gas-water" relative permeability in hydrate-bearing sediments, were found. The lack of studies in this particular issue was most likely due to difficulties in inhibiting hydrate phase change (hydrate formation/dissociation) during gas/water flooding. Most relevant studies were more related to effective permeability measurements of hydrate-bearing sediments during water flooding.
- Preliminary design of test setup was proposed (Figure 2). The validity of the design will be examined in consideration of targeted data collection for gas-water relative permeability measurement in hydrate-bearing sediments. Test equipment and parts, which also includes an electronically-controlled back pressure regulator and a two-phase sonic fluid separator, are to be accordingly obtained.

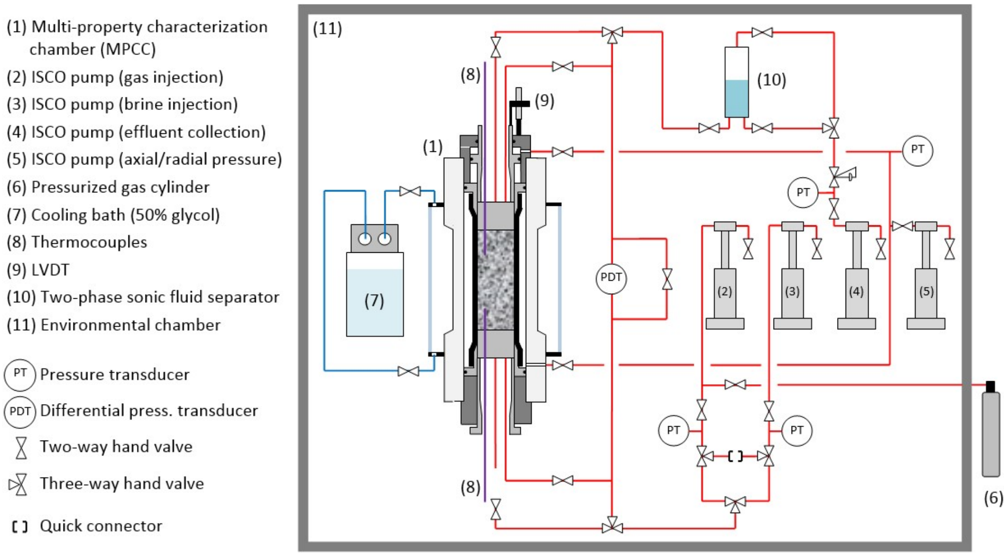


Figure 2: Proposed test setup for relative permeability measurement of hydrate-bearing sediments.

- A plan for upgrading an existing environmental chamber was proposed. The environmental chamber will eventually accommodate our core-flow-test mobile cart (Figure 2), so that the test can be conducted under better control of temperature (less temperature fluctuation).

Subtask 3.2 Tri-Axial Compression Tests on Hydrate-Bearing Sediments with Induced Hydrate Dissociation under Shear Stress

Understanding of geomechanical response of hydrate-bearing sediments (HBS) to hydrate dissociation is critical to safely exploit hydrate accumulations for gas production. In FY15-Q1, a preliminary plan to complete a geomechanical test on HBS subjected to dissociation was proposed to evaluate the deformability of HBS subjected to various scenarios of dissociation.

- A literature review has been conducted to propose an experimental plan for this study.
- Geomechanical tests, based on the proposed preliminary test plan, consist of:
    1. Four core samples
        - Host material: F110 silica sand + 5% Kaolinite Clay
        - Brine-saturated non-cementing HBS sample
        - Initial hydrate saturation, S_h = ~40%
    2. Hydrate dissociation method
        - Depressurization (two samples)
        - Thermal recovery (two samples)

3. Tri-axial drainage compression test during hydrate dissociation
   - Effective confining pressure, $\sigma_o' = 0.69$ MPa
   - Deviator stress, q (effective axial – radial pressure), at which the hydrate dissociation is initiated:

     50% (~1.5 MPa) and 130% (~4 MPa) of peak deviator stress, q_{peak} of host sample (~3 MPa)
   - q will be applied on the HBS sample up to 50% or 130% of q_{peak} of host sample. Hydrate will then be dissociated by either depressurization or thermal recovery method while maintaining the same axial and radial pressures, at which the dissociation is started. The axial strain, axial, radial, and pore pressures will be continuously measured during the entire course of the experiment to establish the stress-strain relationship, as shown in Figure 3.

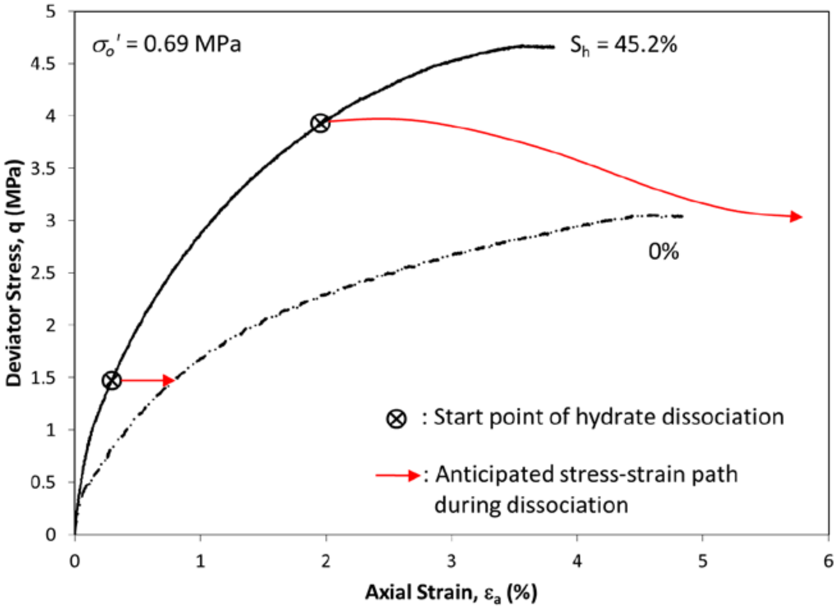


Figure 3: Stress-strain paths during hydrate dissociation anticipated from proposed test plan.

- A plan for minor modification of existing geomechanical test setup is currently being prepared to continuously measure the mass of dissociated methane gas for S_h calculation.
- The test will also be conducted in the upgrading environmental chamber, which can provide better control of temperature (less temperature fluctuation).

Subtask 3.3 Methodology Developments for Modeling Geomechanical Stability of Hydrate-Bearing Sediments under Hydrate Dissociation Condition

Effort has not begun on this subtask; pending supporting research staff emplacement.

Task 4.0 Pore-Scale Visualization and Characterization of Hydrate-Bearing Sediments

Subtask 4.1 Effect of Continuous Brine Flow on Hydrate Formation and Dissociation Behaviors

- Two sets of CT images of hydrate-bearing sediments were obtained. Each set has CT images of sediments before and after hydrate formation (shown in Figures 4 and 5).

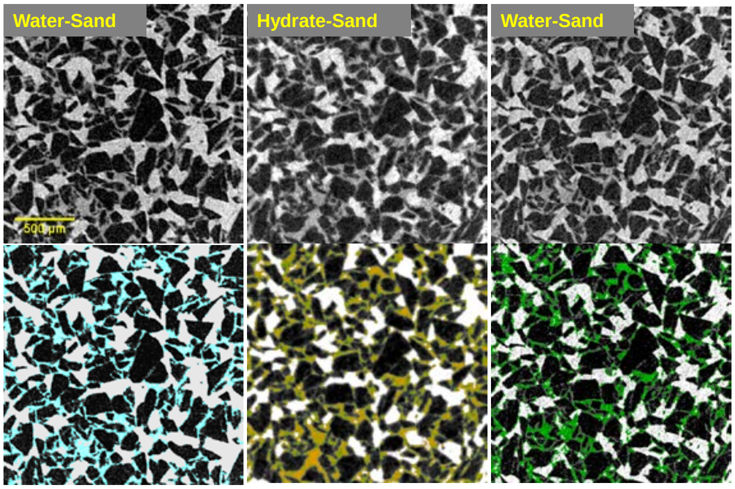


Figure 4: Slice view of partially water saturated sands scanned at (a) atmospheric pressure and room temperature conditions; (b) 7°C and 10MPa gas pressure whereas water turns into hydrate; and (c) atmospheric and room temperature conditions where hydrate has dissociated and turns back into water.

- Water, gas, and hydrate distributions are being studied at different stages of the experiment.

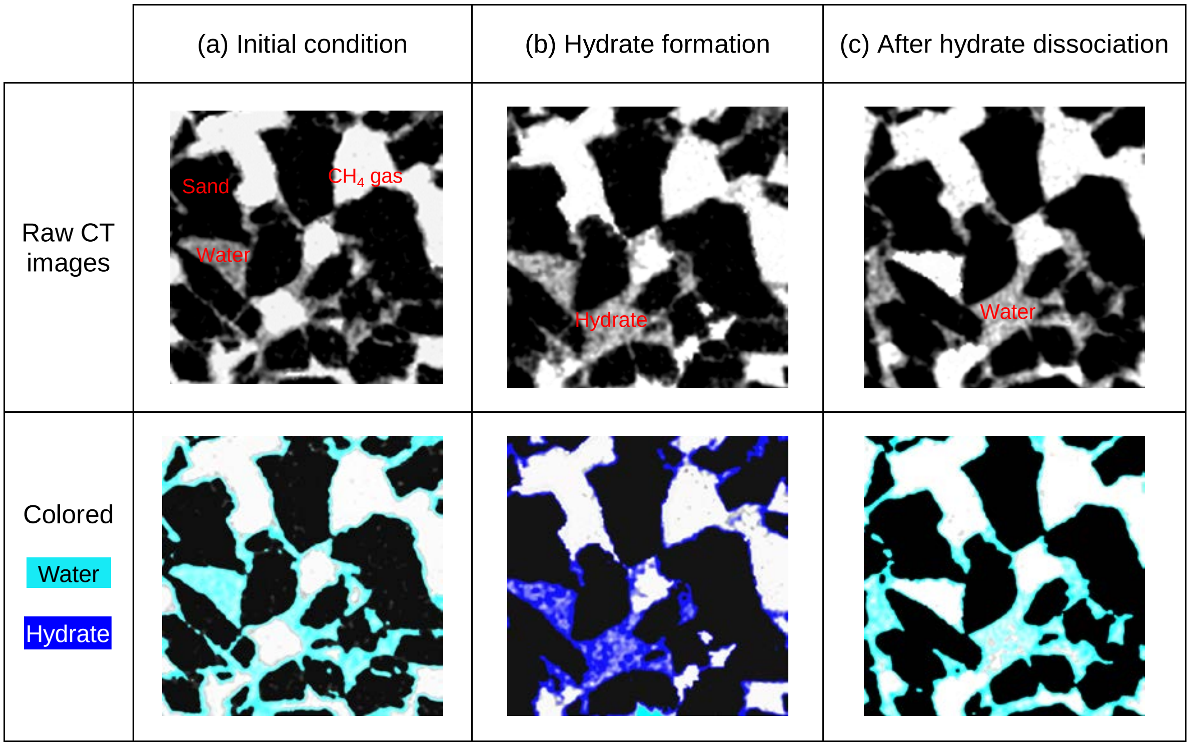


Figure 5: Methane hydrate synthesized in pure silica sands (grain diameter ~110µm) using the excessive-gas method. (a) Partially water saturated sands are purged by methane gas (to remove air) and scanned at atmospheric pressure and room temperature conditions. (b) Hydrate formation is triggered by lowering the temperature to 7°C and pressuring up to 10MPa. (c) Hydrate dissociation is induced by gradually decreasing the chamber pressure down to atmospheric condition.

Subtask 4.2 Water and Gas Distributions after Hydrate Dissociation and Implications to Permeability

- Pore network simulations of hydrate effects on the relative permeability were completed. The pore networks were extracted from 3D CT images of sands from the Mallik hydrate site (Figure 6).

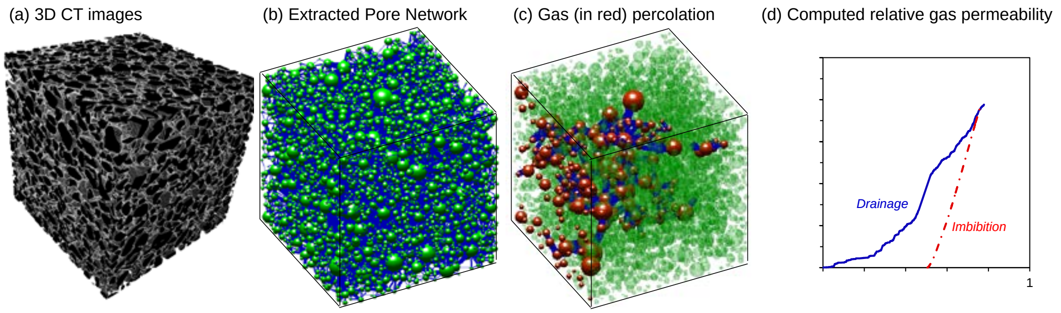

(a) 3D CT images (b) Extracted Pore Network (c) Gas (in red) percolation (d) Computed relative gas permeability

Figure 6: Pore network simulation based on 3D CT images. (a) Obtained 3D CT scanning images of the sands from the Mallik hydrate site. (b) Extracted stick-ball model of the pore network based on the CT images. (c)An illustration of the gas percolation path through the network. (d) Relative gas permeability during the drainage (gas invading water-saturated pore network) and the imbibition (water saturates a dried pore network) processes.

Subtask 4.3 Links between Hydrate Morphologies and Geomechanical Properties

- New endcaps for the Be vessel with capabilities of vertical stress control and wave measurement (to be installed) were designed, machined, and succeeded the leak test (up to 5,500psi) (Figure 7).
- The newly designed endcaps allow vertical effective stress to be applied, while P-wave velocity is measured. Therefore, the hydrate morphology (through CT scanning) will be linked to the geomechanical behavior of hydrate-bearing sediments (small-strain stiffness and large-strain strength).

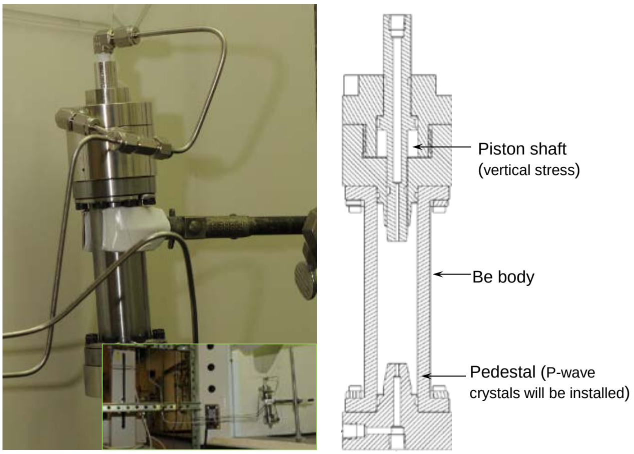


Figure 7: The Be vessel with two new endcaps are under leak test.

Subtask 4.4 Microfluidic-Based Permeability of Hydrate-Bearing Sediments

- The microfluidic chip (purchased from Dolomite Microfluidics) has been flow tested at various differential pressures to determine if it follows Darcy’s Law. Testing has shown that Darcy’s Law is followed (Figure 8).

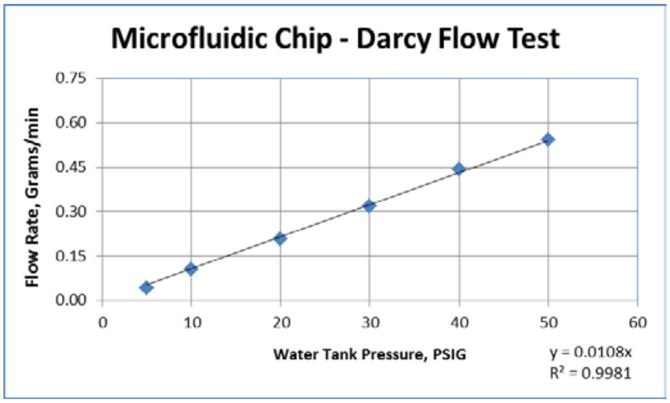


Figure 8: Darcy Flow Test Results.

- The microfluidic chip cooling system was functional and the copper Thermal Transfer Plate (TTP) was machined and was embedded with thermocouples. The cooling system consists of: glycol chiller for system cooling, peltier plates for chilling of the TTP, and proportional-integral-derivative (PID) controllers/Solid-State Relays (SSRs) for control of the peltier plates. The cooling system has been tested and produced the desired linear gradient across the TTP (Figure 9).

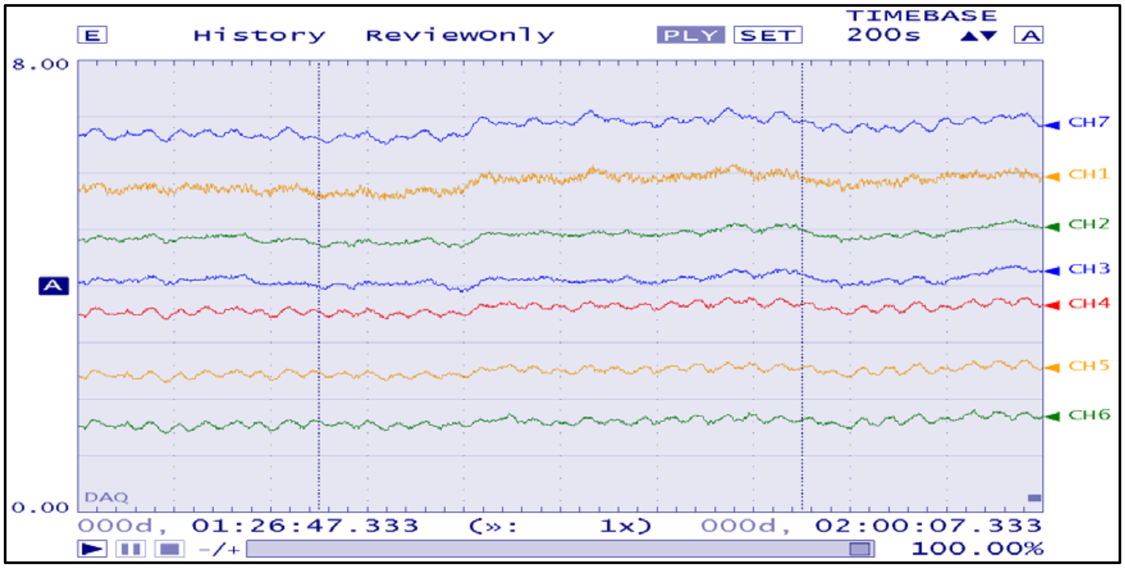


Figure 9: Temperature versus Time Plot of TTP.

- Additional parts were ordered to make the cooling system more robust. These parts include thermocouples to embed in the peltier plate cooling control and higher-fidelity PID controllers. These parts will be delivered in January 2015 and will be incorporated into the system upon arrival.

- The imaging system is currently functional. This equipment was obtained from WVU Chemical Engineering and has low speed/low definition capability (Figures 10-13). Video and still images can be captured from the imaging system. When the initial experiments are conducted, the quality of the imaging will be tested to determine if it meets the needs for visual characterization of hydrate density. Further upgrades to the imaging system may be needed based on these results.
- Construction of the flow system to deliver the water/ tetrahydrofuran (THF) mixture to the microfluidic chip is underway. For THF experimentation, a high-pressure system is not required. Operating conditions will typically be below 50 pounds per square inch gauge (PSIG). Construction of the flow system is expected to be complete in January 2015.

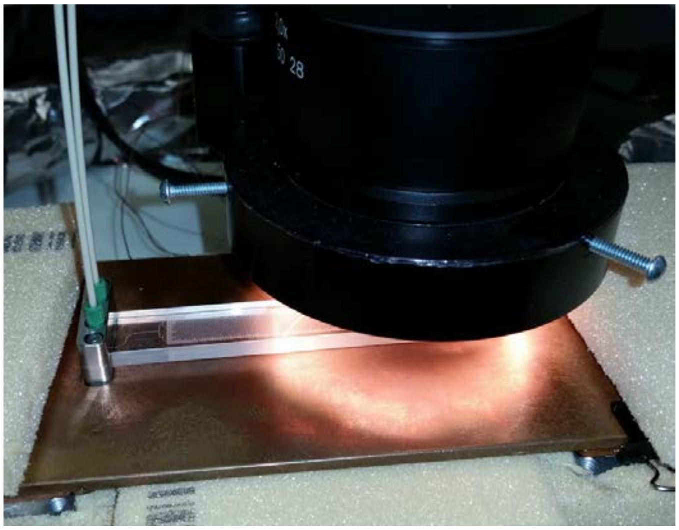


Figure 10: Microfluidic Chip on TTP.

Figure 11: Imaging System and Chip on TTP.

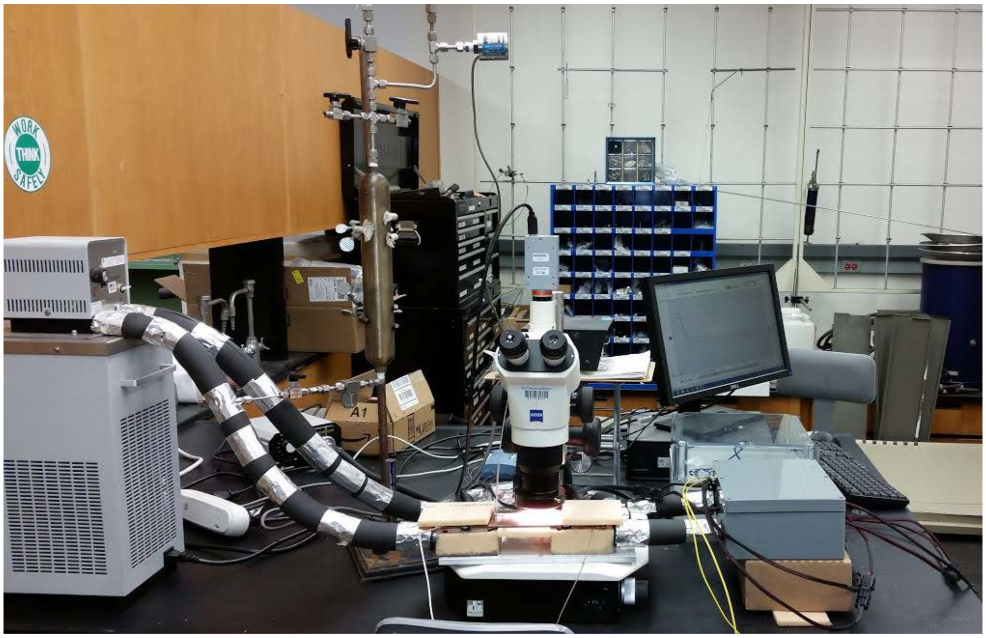


Figure 12: Microfluidic Chip System.

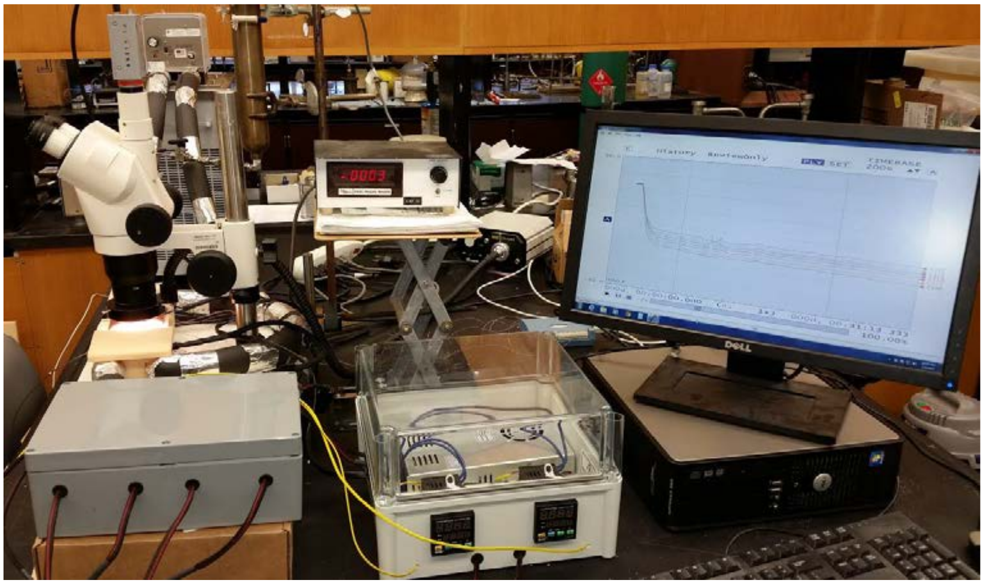


Figure 13: Microfluidic Chip System Controls.

Forecast for Next 6 Months

Task 1.0 Project Management and Outreach

The FY15-Q1 Report will be submitted on January 30, 2015.

Task 2.0 Reservoir Simulation of Gas Hydrates Production Field Tests

Subtask 2.1 Alaska North Slope Production Test Simulation Assistance

The next six months will involve carrying out uncertainty and sensitivity analyses on both the L-Pad and Mt. Elbert models. Field data will be continuously incorporated into the heterogeneous models as they become available. Also, detailed wellbore design and flow assurance studies will be conducted to forestall problems associated with reformation of hydrates within the wellbore during production. This will involve the application of computational fluid dynamics; its results will be coupled with reservoir models.

Subtask 2.2 International Code Comparison Continuation – Iġnik Sikumi History Match Analysis and Marine Deposit Based on the 2013 Nankai Trough Test or Other Marine Sites

In the next six months, the focus will be on understanding the flow kinetics of the CH_4-CO_2 hydrate considering the injection of CO_2 at the top and bottom of the hydrate stability zones of CH_4 and CO_2 hydrates. The focus will also include conducting simulation scenarios using different production techniques to investigate how the reservoir parameters change for each technique, particularly for the geologic formations with high-hydrate saturations. Focus will change from injecting gaseous CO_2 into different reservoir domains to injecting liquid CO_2 by modifying the Mix3HRS code.

Task 3.0 Laboratory Hydrologic and Geomechanical Characterization and Analysis of Hydrate-Bearing Sediments

Subtask 3.1 Laboratory Measurement of Relative Permeability of CH_4 Gas in Brine-Saturated Hydrate-Bearing Sediments

- The literature review will be continued. (FY15-Q2)
- Development of experimental methodology for the relative measurements will be completed. (FY15-Q2)
- The temperature chamber will be ready for the test by adding new gas lines, temperature controller, and gas detectors. (FY15-Q2)
- New equipment and parts will be assembled into the mobile cart. (FY15-Q2)
- The experimental method and test setup will be examined by conducting preliminary tests. (FY15-Q2)
- The first planned test will be conducted by following completed experimental methodology. (FY15-Q3)

Subtask 3.2 Tri-Axial Compression Tests on Hydrate-Bearing Sediments with Induced Hydrate Dissociation under Shear Stress

- Development of reasonable strategy of hydrate dissociation will be completed in consideration of actual HBS conditions anticipated during field production tests. (FY15-Q2)
- An overall test plan will be completed. (FY15-Q2)

- Modification of the existing geomechanical test setup will be completed in accordance with the test plan. (FY-Q2)
- An initial compression test will be conducted, simultaneously examining the test plan and setups. (FY15-Q3)

Subtask 3.3 Methodology Developments for Modeling Geomechanical Stability of Hydrate-Bearing Sediments under Hydrate Dissociation Condition

Effort has not begun on this subtask; pending identification of research staff on the task. The team hopes to validate the constitutive model with experimental data on the modeling of dissociation on stress-strain behavior. The team would also conduct and develop benchmark tests for validating the coupling analysis for geomechanics analysis of operational scenarios, for use in such cases as methane extraction from the ground.

Task 4.0 Pore-Scale Visualization and Characterization of Hydrate-Bearing Sediments

Subtask 4.1 Effect of Continuous Brine Flow on Hydrate Formation and Dissociation Behaviors

- To follow the NETL’s recipe of forming noncementing hydrate and obtain CT images of hydrate pore habits at each critical steps using the Be vessel.

Subtask 4.2 Water and Gas Distributions after Hydrate Dissociation and Implications to Permeability

- To obtain CT images of residual water and gas distributions after hydrate distribution.
- To perform pore network modeling to simulate observed processed and extend the model to other conditions (varying in hydrate saturation, hydrate distribution, pore statistics, etc.) relevant to field conditions.

Subtask 4.3 Links between Hydrate Morphologies and Geomechanical Properties

To use the Be vessel with new endcaps to study the effects of hydrate morphologies on the measured stiffness (i.e., wave velocity) and strength of hydrate-bearing sediments.

Subtask 4.4 Microfluidic-Based Permeability of Hydrate-Bearing Sediments

Beginning in January 2015, experiments with THF hydrate will be conducted to test the system and determine the ability to process images from the experiments. Based on this data, further refinements may be needed to parts of the system to move forward. Image processing will be conducted with ImageJ.

The first experiment will produce THF hydrate in the microfluidic chip without using a temperature gradient. The goal of the experimentation will be to correlate hydrate density to flow, which will show how the permeability of the microfluidic chip changes as hydrate density increases. Once initial testing of THF hydrates are complete, a temperature gradient will be induced to increase the density of hydrate formed, attempting to mimic real world hydrate densities.

Products

Publications, Conference Papers, and Presentations

Dai, S., Seol, Y., and Choi, J.H., "Impacts of Hydrate Pore Habits on the Physical Properties of Hydrate Bearing Sediments," AGU Fall Meeting Abstracts, 2014, B11B-0011. (Subtask 4.3)

Mahabadi, N., Dai, S., Seol, Y., and Jang, J., "Water Retention Curve and Relative Permeability for Gas Production from Hydrate-Bearing Sediments," AGU Fall Meeting Abstracts, 2014, B11B-0019. (Subtask 4.2)

Seol, Y., Choi, J.H., Dai, S., and Jarvis, K., "Understanding the Physical Properties of Hydrate Bearing Sediments at Pore- and Core-Scales," *Fire in the Ice*, under internal review. (Tasks 3.0 and 4.0)

Websites or Other Internet Sites

Hydrate research activity was featured in *Researchnews*, October 2014, Issue 1, p. 3, "Revealed Secrets in Locked in ICE" and "NETL In-House Research Program: Natural Gas Hydrate R&D" page http://www.netl.doe.gov/File%20Library/Library/Newsroom/researchnews/Research_News_October2014_101514.pdf

Changes/Problems

Deploying the Be vessel for hydrate studies may be delayed, as a result of other projects being behind schedule that engage the Be vessel and the micro-XCT. Aluminum core holders are being designed to be used for Industrial CT (Subtasks 4.1 and 4.3).

On October 17, 2014, our site support contractor, URS Corporation, joined resources with AECOM. They now operate as a single company under the name AECOM. In this document, references to the company address the site support contractor as URS/AECOM.

Appendix A: Participating and Other Collaborating Organizations

Table A-1 includes the name and organization of all federal, URS/AECOM, university, and ORISE participants. Each quarter, changes or additions will be shown in highlighted yellow text.

Table A-1: Natural Gas Hydrates Research Portfolio
Participating and Collaborating Organizations

Task/Subtask Number – Name	Name	Organization
Task 1.0 Project Management and Outreach		
Subtasks 1.1-1.4 Project Management and Outreach	Gary Sames Yongkoo Seol	NETL-ORD
	Jeffery Ilconich	URS/AECOM
Subtask 1.5 Outreach	Yongkoo Seol	NETL-ORD
	Jeffery Ilconich	URS/AECOM
Subtask 1.6 Portfolio Management	Yongkoo Seol	NETL-ORD
	Jeffery Ilconich	URS/AECOM
Task 2.0 Reservoir Simulation of Gas Hydrates Production Field Tests		
Subtask 2.1 Alaska North Slope Production Test Simulation Assistance	Yongkoo Seol	NETL-ORD
	Taiwo Ajayi Prathyusha Sridhara	ORISE
Subtask 2.2 International Code Comparison Continuation – Iġnik Sikumi History Match Analysis and Marine Deposit Based on the 2013 Nankai Trough Test or Other Marine Sites	Yongkoo Seol	NETL-ORD
	Taiwo Ajayi Prathyusha Sridhara	ORISE
Task 3.0 Laboratory Hydrologic and Geomechanical Characterization and Analysis of Hydrate-Bearing Sediments		
Subtask 3.1 Laboratory Measurement of Relative Permeability of CH4 Gas in Brine-Saturated Hydrate-Bearing Sediments	Yongkoo Seol	NETL-ORD
	Jeong-Hoon Choi	ORISE
Subtask 3.2 Tri-Axial Compression Tests on Hydrate-Bearing Sediments with Induced Hydrate Dissociation under Shear Stress	Yongkoo Seol	NETL-ORD
	Jeong-Hoon Choi	ORISE
Subtask 3.3 Methodology Developments for Modeling Geomechanical Stability of Hydrate-Bearing Sediments under Hydrate Dissociation Condition	Yongkoo Seol	NETL-ORD
	TBD	TBD

Task/Subtask Number – Name	Name	Organization
Task 4.0 Pore-Scale Visualization and Characterization of Hydrate-Bearing Sediments		
Subtask 4.1 Effect of Continuous Brine Flow on Hydrate Formation and Dissociation Behaviors	Yongkoo Seol	NETL-ORD
	Sheng Dai Terrance Ryan Matthew Tacker	ORISE
Subtask 4.2 Water and Gas Distributions after Hydrate Dissociation and Implications to Permeability	Yongkoo Seol	NETL-ORD
	Sheng Dai Terrance Ryan Matthew Tacker	ORISE
Subtask 4.3 Links between Hydrate Morphologies and Geomechanical Properties	Yongkoo Seol	NETL-ORD
	Sheng Dai Terrance Ryan Matthew Tacker	ORISE
Subtask 4.4 Microfluidic-Based Permeability of Hydrate-Bearing Sediments	Yongkoo Seol	NETL-ORD
	Sheng Dai Terrance Ryan Matthew Tacker	ORISE