Oil & Natural Gas Technology

DOE Award No.: DE- FE0013961

Quarterly Research Performance Progress Report
(Period ending 06/30/2016)

Borehole Tool for the Comprehensive Characterization of Hydrate-Bearing Sediments

Project Period (10/1/2013 to 9/30/2017)

Submitted by:
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National Energy Technology Laboratory

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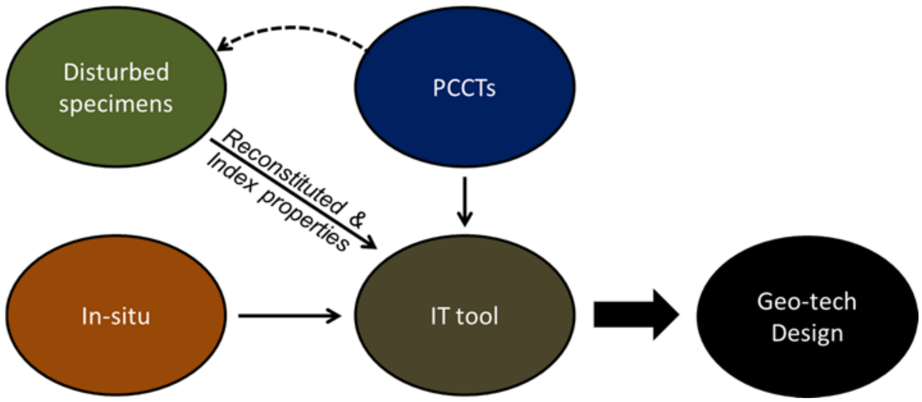
Office of Fossil Energy

DISCLAIMER:

Context – Goals.

The physical properties of hydrate bearing sediments are critical for gas production strategies, geo-hazard mitigation and its impact on gas recovery engineering. Typically, the determination of physical properties relies on correlations and experimental data recovered from conventional and pressure cores. Inherent sampling disturbance and testing difficulties add significant uncertainty. In this research, we develop a new comprehensive borehole tool for the characterization of hydrate bearing sediments, and an IT tool for the physics-bases selection of appropriate parameters.



Accomplishments

The main accomplishments for this period include:

- Borehole tool design:
    - New main body: construction and pressure testing completed
    - New camera module: completed machining
    - Thermal module: preliminary proof-of-concept design

Plan - Next reporting period

Field deployment of this borehole tool is scheduled beginning the 2nd week of August. We plan to deliver in next reporting period:

(1) a report on field tests on KAUST marina,

(2) lab testing of the prototype thermal module,

(3) modifications / updates of the tool and electronics after field deployment.

Research in Progress

<u>Borehole Tool – Pre-deployment Modification</u>

The newly constructed tool main body and modules are ready for deployment at KAUST marina (Figure 1). The modified tool has passed the high-pressure leaking testing (Figure 2). Full deployment in Red Sea is scheduled in early December.

Figure 1. Newly constructed tool main body to be deployed in KAUST marina.

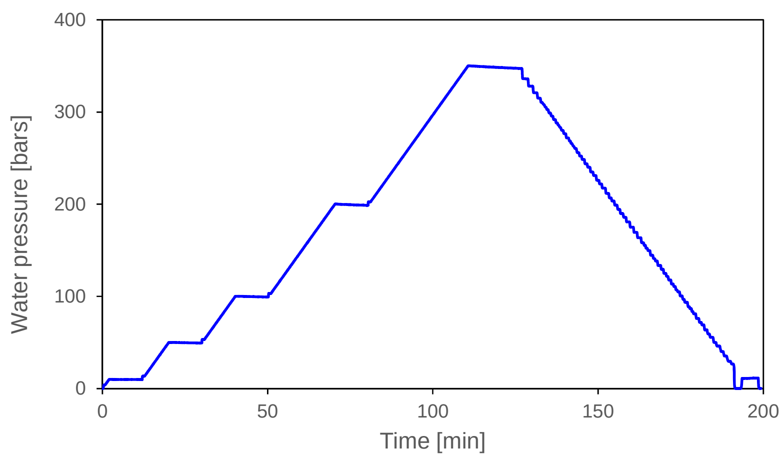


Figure 2. Results of the leaking test for the newly constructed tool.

Thermal Module Development: Preliminary Studies

The original proposal does not include a thermal module; yet, the no-cost time extension of this project intends to develop a thermal module that allows to characterize the thermal properties of hydrate deposits at in situ conditions. The design of the thermal module is based on the single-sided transient plane source (S-TPS) technique that developed at NETL. We report herein numerical investigations on the factors influencing heat conduction and sensor design.

Impacts of contact size, stainless steel of the cone, and potential dual S-TPS on measured thermal properties have been thoroughly investigated (Figure 3).

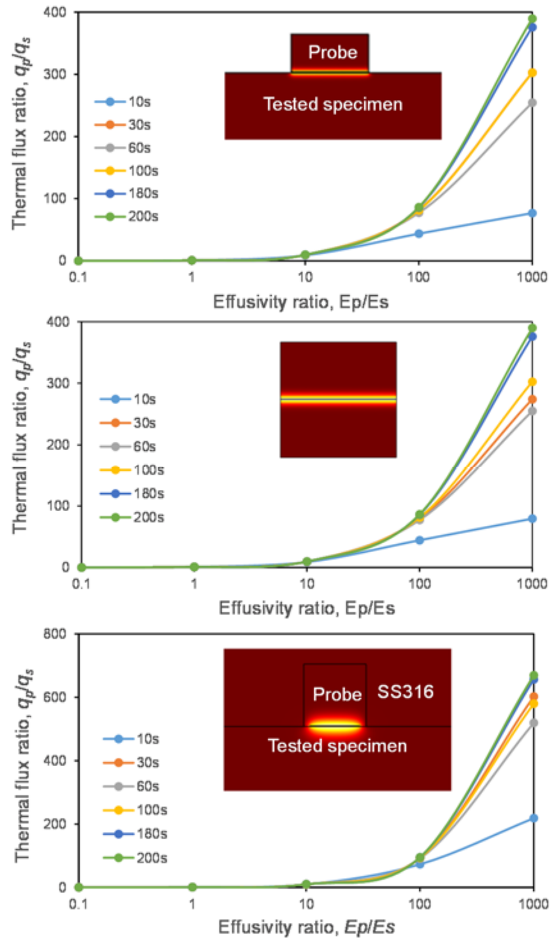


Figure 3. Impacts of the S-TPS probe configuration on measured thermal properties of the specimens. The x-axis reflects the effusivity (density x thermal conductivity x thermal diffusivity) ratio between the thermal probe and the tested specimen; the y-axis reflects the thermal flux ratio between the probe and the tested specimen. Scenarios of different duration of current injection have also been considered (from 10s to 200s) in order to identify optimum measurement duration.

Numerical investigations also include investigating the effects of material heterogeneity on the thermal properties measurement (Figure 4). Laboratory prototype probe testing is undergoing. Several influencing factors, such probe diameter, cone penetration disturbance, etc, will be studied and summarized in next report.

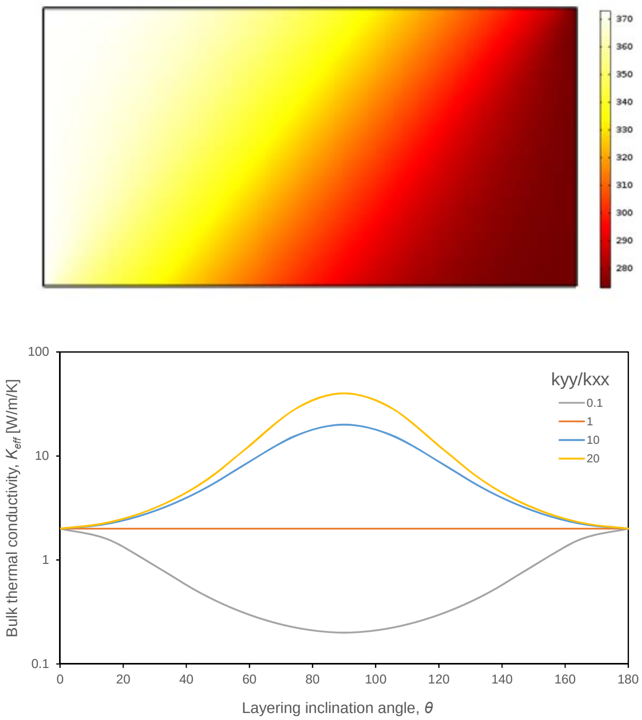


Figure 4. Effects of layering and heterogeneity on measured bulk thermal properties. Heat conduction occurs from the left boundary to the right, with the upper and lower boundaries insulated. k_{xx} and k_{yy} are material thermal conductivity at horizontal and vertical directions.

<u>Coupling with IODP BHAs</u>

We are working together with Pettigrew Engineering to develop a CDS-type coupling system that allow the deployment of this borehole tool within the IODP APC/XCB BHA, which is compatible with the PCTB BHA as well. The PCTB and all of the IODP tools use a 4” OD landing ring, which causes the major needed modification of the borehole tool to be preferentially 3.75” OD (Note that our current borehole tool has an OD = 4”). This will be modified together with others after several times of tool deployment at KAUST marina and in the Red Sea.

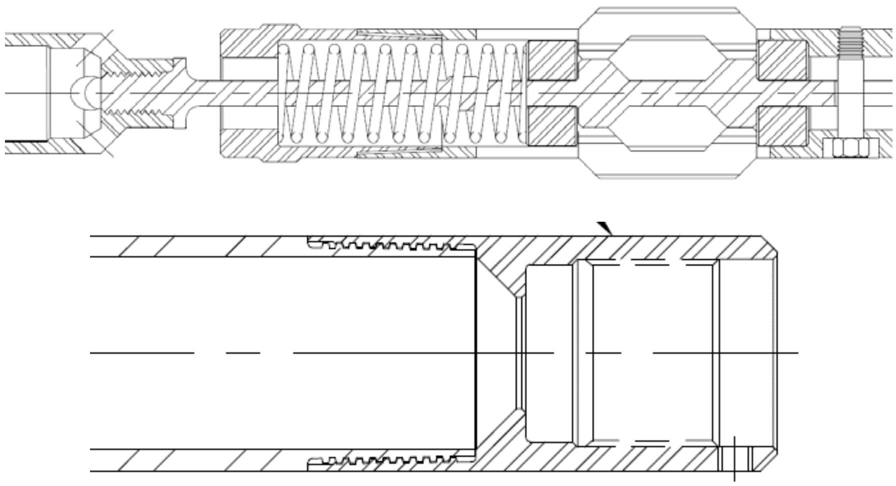


Figure 5. Preliminary design of a CDS-type coupling between the borehole tool and the IODP BHA. Top: standard XCB latch assembly. Bottom: Core barrel quick release adapter. Other designs include safety release collet, sliding collet, landing sub, and internal/external stoppers (Pettigrew Engineering).

MILESTONE LOG

	Milestone	Completion Date	Comments
Title Planned Date Verification method	Completion PMP November 2013 Report	11/2013	
Title Planned Date Verification method	Insertion – Tool design September 2014 Report	9/2014	
Title Planned Date Verification method	Database and IT tool September 2014 Report	9/2014	
Title Planned Date Verification method	Electronics in operation January 2015 Report	1/2015	New generation of electronics and pack-aging method in pro-gress
Title Planned Date Verification method	Lab testing of prototype September 2015 Report	6/2015	
Title Planned Date Verification method	Tool deployment Before September 2016 Report	In progress	Next deployment isscheduled in the 2^{nd} week of August

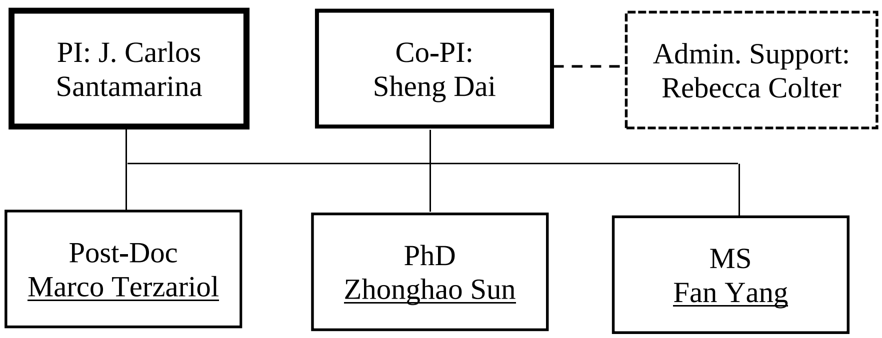
PRODUCTS

- **Publications – Presentations:** None at this point
- **Website:** Publications and key presentations are included in http://egel.kaust.edu.sa/. (for academic purposes only)
- **Technologies or techniques:** None at this point.
- **Inventions, patent applications, and/or licenses:** None at this point.
- **Other products:** None at this point.

PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

Research Team: The current team involves:

- Marco Terzariol (Post-Doc)
- Zhonghao Sun (PhD student)
- Fan Yang (MS student)
- Sheng Dai (Assistant Professor)
- Carlos Santamarina (Professor)



IMPACT

None at this point.

CHANGES/PROBLEMS:

No-cost time extension to 9/30/2017 has been requested.

SPECIAL REPORTING REQUIREMENTS:

We are progressing towards all goals for this project.

BUDGETARY INFORMATION:

As of the end of this research period, expenditures are summarized in the following table.

Baseline Reporting Quarter DE-FE0013961	Budget Period 3							
	Q1		Q2		Q3		Q4	
	10/1/15 - 12/31/15		1/1/16 - 3/31/16		4/1/16 - 6/30/16		7/1/16 - 9/30/16	
	Q1	Cumulative Total	Q2	Cumulative Total	Q3	Cumulative Total	Q4	Cumulative Total
Baseline Cost Plan								
Federal Share	30,000	345,515	30,000	375,515	30,000	405,515	71,510	477,025
Non-Federal Share	14,693	97,103	14,692	111,795	14,693	126,488	-	126,488
Total Planned	44,693	442,618	44,692	487,310	44,693	532,003	71,510	603,513
Actual Incurred Cost								
Federal Share	6,315	250,608	28,411	279,020	51,392	330,412		330,412
Non-Federal Share	15,655	93,760	10,436	104,196	5,218	109,415		109,415
Total Incurred Costs	21,969	344,368	38,848	383,216	56,611	439,826	-	439,826
Variance								
Federal Share	-23,685	-94,907	-1,589	-96,495	21,392	-75,103		
Non-Federal Share	962	-3,343	-4,256	-7,599	-9,475	-17,073		
Total Variance	-22,724	-98,250	-5,844	-104,094	11,918	-92,177		

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