DOE Award No.: DE-FE0013961
Quarterly Research Performance Progress Report
(Period Ending 03/31/2017)

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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Signature

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United States Department of Energy
National Energy Technology Laboratory

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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:

- Finalized tool design based on field deployment experience and geometric constrains in order to be coupled with PCTB BHA

Plan - Next reporting period

1. Machining of the tool with new dimensions
2. Updated electronics design
3. Tool coupling with PCTB BHA
Research in Progress

Updated Tool Dimensions

*Geometric constrains.* Shallow depth cone-based site investigation typically uses a clump weight resting on the seafloor to anchor the drill string to avoid the residual heave from the drilling string. Previous two field deployment of this tool used a similar method. For deep depth tool deployment like IODP works, different mechanisms are used to avoid the residual heave problem. The borehole tool must be coupled with Collected Delivery system (CDS) or Mechanically Decoupled Hydraulic Delivery System (MDHDS) to be deployed in compatible with IODP tools. To be compatible with the PCTB BHA or the IDOP APC/XCB BHA, the maximum OD of the tool must be less than four inches, which is the OD of the current tool. Modifications of this tool have been made to meet this requirement.

![Diagram](image)

**Figure 1.** New dimension of the tool body (left) and bottom cap (right). The top cap is to be determined based on CSD design.

Limited by the size the solenoid value, the maximum inner diameter of the tool body is 3.2 inches. Thus, the buckling stress for the body with this dimension is shown in Figure 2. All these dimensions will be finalized and machined in next reporting period.
Figure 2. Length dependent buckling stress of the tool body with modified ID and OD dimensions. The double lines show the upper and lower bounds based on the maximum and minimum elastic modulus of SS316 from various manufacturers, i.e., $E_{\text{max}} = 205\text{GPa}$ and $E_{\text{min}} = 190\text{GPa}$.

**Electronics configuration.** Data measurement and collection systems have been updated as well after the field deployment. Further work will involve lab testing of each module and reconfiguration of installation within the modified tool body.

Figure 3. Latest version of electronics configuration (updated after field deployment). Left: joint connection of Raspberry Pi and Arduino Mega. Right: Arduino Mega with peripheral data amplifiers.
MILESTONE LOG

<table>
<thead>
<tr>
<th>Title</th>
<th>Planned Date</th>
<th>Verification method</th>
<th>Completion Date</th>
<th>Comments</th>
</tr>
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<tbody>
<tr>
<td>Completion PMP</td>
<td>November 2013</td>
<td>Report</td>
<td>11/2013</td>
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<td>Insertion – Tool design</td>
<td>September 2014</td>
<td>Report</td>
<td>9/2014</td>
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<td>Database and IT tool</td>
<td>September 2014</td>
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<td>9/2014</td>
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<td>Electronics in operation</td>
<td>January 2015</td>
<td>Report</td>
<td>1/2015</td>
<td>Finalizing electronics and packaging method based on field tests.</td>
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<td>Tool deployment</td>
<td>Before September 2016</td>
<td>Report</td>
<td>9/2016</td>
<td>To be sent for machine shop work.</td>
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PRODUCTS

- **Publications – Presentations:**
  


- **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:

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:
None at this point.

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. Note that this project is within the 1st year NCE period; all personnel budget has been spent up to date and the left fund is only for borehole tool machining, electronics procurement, and CDS coupler design and machining.

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<th>Baseline Reporting Quarter</th>
<th>DE FE0113961</th>
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<td>Baseline Cost Plan</td>
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