NATIONAL ENERGY TECHNOLOGY LABORATORY

OIL & GAS

DOE Award No.: DE-FE0013961

Quarterly Research Performance Progress Report (Period Ending 09/30/2017)

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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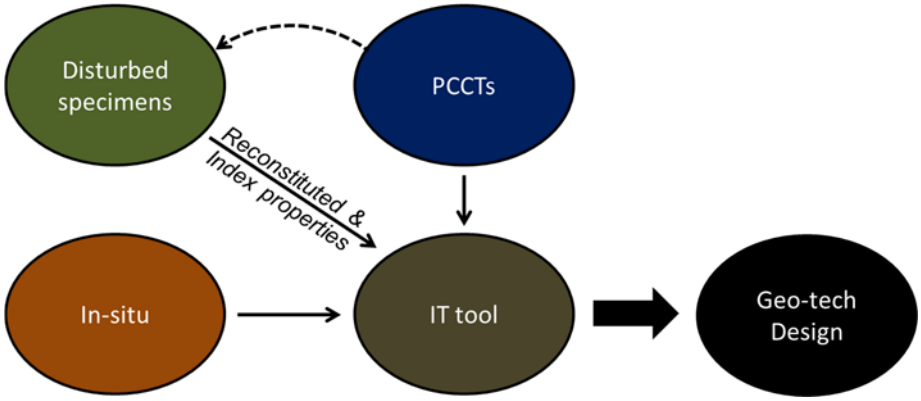
U.S. DEPARTMENT OF ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY

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:

- Updated electronics
- Tool fabrication, assembly, and CDS coupling design

Plan - Next report will be the final report of this project

Research in Progress

Final electronics configuration

Table 1 summarizes the pertinent parameters and properties of hydrate-bearing sediments for characterization and gas production simulation. Details will be documented in the final report.

Table 1. A list of pertinent parameters for hydrate-bearing sediments characterization and gas production simulation. Properties in red can be obtained using the current tool as originally proposed for this project, and in blue are critical parameters with potential to be developed in near future based on the knowledge learned from this project.

Index Properties and Reservoir Characteristics	In-situ temperature – pressure
	In-situ stresses
	Porosity – Hydrate saturation
	Grain size distribution – Fines content, mineralogy
	Stratigraphy / hydrate morphology
	Formation history
	Salinity
	Pore water geo-chemistry
Thermal Properties	Thermal conductivity
	Specific heat and latent heat
Hydraulic Properties	Water retention curve - Relative k
	Hydraulic conductivity
	Potential migration pathways
Mechanical Properties	Lateral stress coefficient
	Soil Stiffness: shear and bulk stiffness
	Strength
	Stress-dependent dilatancy
	Compressibility upon dissociation

The final configuration of the electronics, modified after the latest dimension of the tool, is shown in Figure 1. Details will be documented in the final report.

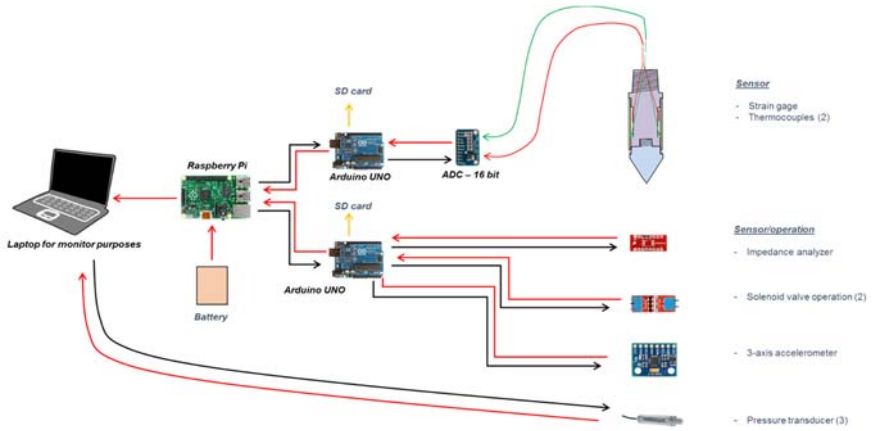


Figure 1. The assembly of electronics.

Tool fabrication, assembly, and CDS coupling design

Figure 2 shows some of the major components of the cone-based borehole tool and the key components of a CDS-type coupler in compatible with both the PCTB BHA and the APC/XCB BHA. More details will be documented in the final report.

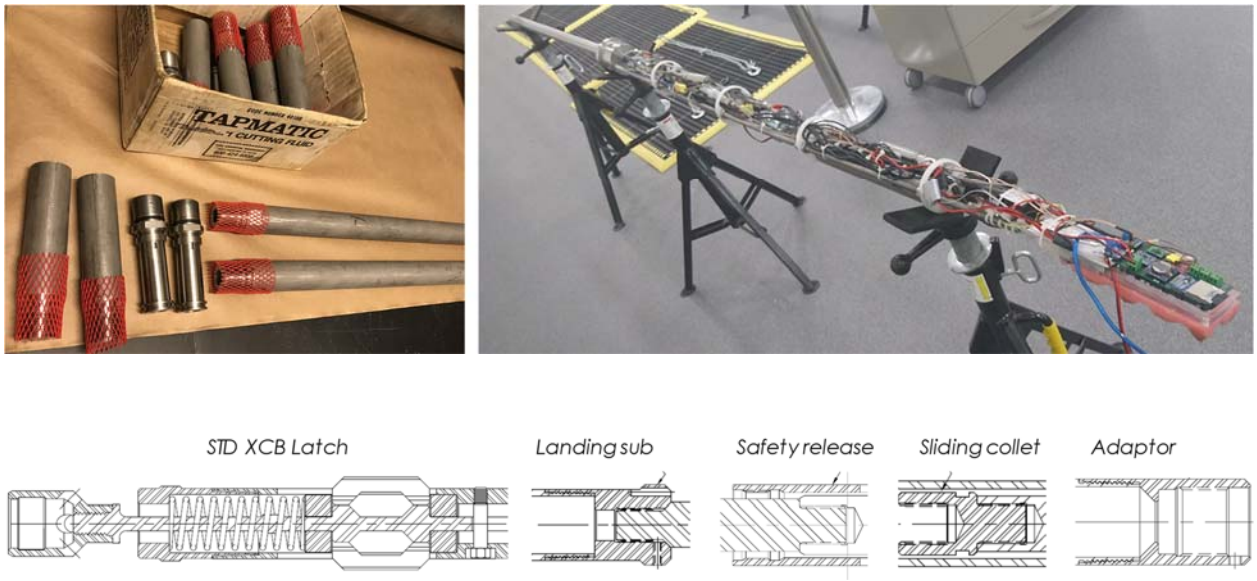


Figure 2. (Upper images) Major parts and assembly of the tool. (Lower images) Key components of a CDS-type coupler with PCTB BHA.

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	
Title Planned Date Verification method	Lab testing of prototype September 2015 Report	6/2015	Tool fabrication
Title Planned Date Verification method	Tool deployment Before September 2016 Report	9/2016	PCTB BHA coupler fabrication

PRODUCTS

- **Publications – Presentations:**

  Yang, F. and Dai, S. (2017). Thermal properties measurements for hydrate-bearing sediments using single-sided heat source. *9th International Conference on Gas Hydrates*, June 25-30, 2017, Denver, CO.

  Dai, S., Santamarina, J. C. (2017). Stiffness Evolution in Frozen Sands Subjected to Stress Changes. *Journal of Geotechnical and Geoenvironmental Engineering*, 04017042.

  Dai, S., Shin, H., Santamarina, J. C. (2016). Formation and development of salt crusts on soil surfaces. *Acta Geotechnica*, 11(5), 1103-1109.

  Dai, S., Santamarina, J. C. (2014). Sampling disturbance in hydrate-bearing sediment pressure cores: NGHP-01 expedition, Krishna–Godavari Basin example. *Marine and Petroleum Geology,* 58, 178-186.

  Dai, S., Lee, J. Y., Santamarina, J. C. (2014). Hydrate nucleation in quiescent and dynamic conditions. *Fluid Phase Equilibria*, 378, 107-112.

- **Website:** Publications and key presentations are included in http://egel.kaust.edu.sa/ (for academic purposes only)

- **Technologies or techniques:** None at this point.

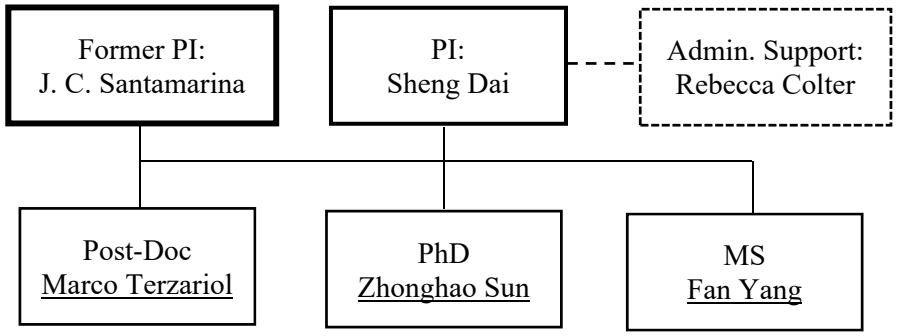
- **Inventions, patent applications, and/or licenses:** None at this point.
- **Other products:**

  Terzariol, M. (2015). Laboratory and field characterization of hydrate bearing sediments-implications. PhD Thesis, Georgia Institute of Technology.

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:

None at this point.

BUDGETARY INFORMATION:

All budget has been zeroed out. Details will be presented in the final report.

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