Oil & Natural Gas Technology

DOE Award No.: DE-FC26-01NT41330

Semi-Annual Progress Report #41330R23 (April 2012 – September 2012)

Characterizing Natural Gas Hydrates in the Deep Water Gulf of Mexico: Applications for Safe Exploration and Production Activities

Principal Investigator:
John T. Balczewski
Chevron Energy Technology Company
6001 Bollinger Canyon Road, CHVPKD/D1248
San Ramon, CA 94583

Prepared for:
United States Department of Energy
National Energy Technology Laboratory

October 2012

Office of Fossil Energy

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ABSTRACT

In 2000, Chevron began a project to learn how to characterize the natural gas hydrate deposits in the deepwater portions of the Gulf of Mexico. A Joint Industry Participation (JIP) group formed in 2001, and a project partially funded by the U.S. Department of Energy (DOE) began in October 2001. The **primary objective** of this project is to develop technology and data to assist in the characterization of naturally occurring gas hydrates in the deep water Gulf of Mexico (GOM). These naturally occurring gas hydrates can cause problems relating to drilling and production of oil and gas, as well as building and operating pipelines. Other objectives of this project are to better understand how natural gas hydrates can affect seafloor stability, to gather data that can be used to study climate change, and to determine how the results of this project can be used to assess if, and how gas hydrates act as a trapping mechanism for shallow oil, or gas reservoirs.

During April 2012 – September 2012 Project activities included:

- **Completion of modifications to the Instrumented Pressure Test Cell (IPTC) and construction/tests of the Pressure Core Characterization Tool (PCCT).**
- **Joint IPTC and PCCT fit-up, shop testing and operator training.**
- **Meetings at Aumann & Associates to discuss pressure corer options.**
- **Evaluating various options and costs for pressure corer service units.**
- **Evaluating various options and costs for onshore test sites.**
- **Remaining on a "monitor and minimum spend" mode while awaiting detailed analyses and design modification recommendations for the Aumann and Associates' prototype Hybrid PCS used by JOGMEC during their July 2012 hydrate pressure coring expedition offshore Japan.**

More information is available on the NETL website: http://www.netl.doe.gov/technologies/oil-gas/FutureSupply/MethaneHydrates/projects/DOEProjects/CharHydGOM-41330.html

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1.0 Introduction

In 2000, Chevron Petroleum Technology Company began a project to learn how to characterize the natural gas hydrate deposits in the deepwater portion of the Gulf of Mexico. Chevron is an active explorer and operator in the Gulf of Mexico, and is aware that natural gas hydrates need to be understood to operate safely in deep water. In August 2000, Chevron working closely with the National Energy Technology Laboratory (NETL) of the United States Department of Energy (DOE) held a workshop in Houston, Texas, to define issues concerning the characterization of natural gas hydrate deposits. Specifically, the workshop was meant to clearly show where research, the development of new technologies, and new information sources would be of benefit to the DOE and to the oil and gas industry in defining issues and solving gas hydrate problems in deep water.

Based on the workshop held in August 2000, Chevron formed a Joint Industry Project (JIP) to write a proposal and conduct research concerning natural gas hydrate deposits in the deepwater portion of the Gulf of Mexico. Chevron generated a research proposal which was submitted to DOE in April 2001 under a competitive DOE funding opportunity announcement (FOA). That application was selected for award by DOE under the FOA and Chevron was awarded a cooperative agreement for research based on the proposal.

The title of the project is **"Characterizing Natural Gas Hydrates in the Deep Water Gulf of Mexico: Applications for Safe Exploration and Production Activities".**

1.2 Objectives

The **primary objective** of this project is to develop technology and data to assist in the characterization of naturally occurring gas hydrates in the deep water Gulf of Mexico (GOM). These naturally occurring gas hydrates can cause problems relating to drilling and production of oil and gas, as well as building and operating pipelines. Other objectives of this project are to better understand how natural gas hydrates can affect seafloor stability, to gather data that can be used to study climate change, and to determine how the results of this project can be used to assess if and how gas hydrates act as a trapping mechanism for shallow oil or gas reservoirs.

1.3 Project Phases

The project is divided into phases. **Phase I** of the project is devoted to gathering existing data, generating new data, and writing protocols that will help the research team determine the location of existing gas hydrate deposits. During **Phase II** of the project, Chevron will drill hydrate data collection wells to improve the technologies required to characterize gas hydrate deposits in the deepwater GOM using seismic, core and logging data. **Phase III** of the project began in September of 2007 and will focus on obtaining logs and if possible cores of hydrate bearing sands in the GOM.

1.4 Research Participants

In 2001, Chevron organized a Joint Industry Participation (JIP) group to plan and conduct the tasks necessary for accomplishing the objectives of this research project. As of September 2012 the members of the JIP were Chevron, Schlumberger, ConocoPhillips, Halliburton, the U.S. Bureau of Ocean Energy Management (BOEM), Total, Japan Oil, Gas and Metals National Corporation (JOGMEC), Reliance Industries Limited, The Korean National Oil Company (KNOC), and Statoil.

1.5 Research Activities

The research activities began officially on October 1, 2001. However, very little activity occurred during 2001 because of the paperwork involved in getting the JIP formed and the cooperative agreement between DOE and Chevron in place. Semi-Annual and Topical Reports have been written that cover the activity of the Project through September 2012.

1.6 Purpose of This Report

The purpose of this report is to document the activities of the Project during April 2012 – September 2012. *It is not possible to put everything into this Semi-Annual report, however, many of the important results are included and references to the NEL Project website:*

http://www.netl.doe.gov/technologies/oil-gas/FutureSupply/MethaneHydrates/projects/DOEProjects/CharHydGOM-41330.html/

The discussion of the work performed during this report period is organized by task and subtask for easy reference to the technical proposal and the DOE contract documents.

2.0 Executive Summary

The Cooperative Agreement is now moving toward its conclusion. The JIP and DOE have determined that they will focus full attention on the development and testing of an integrated suite of pressure coring and pressure core analysis devices in collaboration with research and development experts in the US Department of Energy, U.S. Geological Service, Georgia Tech, Scripps Institution of Oceanography and other academic institutions as well as Aumann and Associates Inc, Geotek and other and contractors. No other drilling programs will be conducted.

During the current reporting period modifications to the Instrumented Pressure Test Cell (IPTC) and construction and shop testing of the Pressure Core Characterization Tool (PCCT) were completed. In addition a joint USGS and Georgia Tech operational test of the IPTC and PCCT was held in June at Georgia Tech in order to verify fit-up of the devices and integrated operation. These tests were successful. The Japanese organizations JOGMEC and AIST have very generously extended an invitation for the JIP to field test the IPTC and PCCT at the AIST hydrate laboratory in Sapporo, Japan analyzing some of the methane hydrate pressure cores captured by JOGMEC in July 2012 while using the prototype Hybrid PCS. Such an opportunity to field test the JIP devices under real-world conditions is invaluable and sincerely appreciated. The field trials are very tentatively planned for late 2012.

Other than IPTC and PCCT development work, the remainder of the project is in a "monitor and minimum spend" mode while awaiting full results of the July 2012 JOGMEC deployment of the hybrid PCS offshore Japan and subsequent detailed analyses and design modification recommendations.

Other activities during the reporting period included:

- Several detailed technical meetings held at Aumann & Associates to discuss JIP pressure corer options. These meetings provided the attendees with an excellent understanding of the prototype Hybrid PCS design, tool options and associated costs. Final selection will be made after availability of full results of the July 2012 JOGMEC deployment of the hybrid PCS offshore Japan and subsequent detailed analyses and design modification recommendations.

- Three coring operation service van options were generated and evaluated. Options included a non-standard 33’ service van length (currently used by Aumann & Associates), a 40’ ISO standard length service van with ability to be cut down to 33’ if needed in the future, and a 40’ ISO standard length service van. Final selection will be made after availability of full results of the July 2012 JOGMEC deployment of the hybrid PCS offshore Japan and subsequent detailed analyses and design modification recommendations.
- Three options for onshore test sites were evaluated including visits to two of the sites. Cost and technical information was collected and evaluated. Final selection will be made after availability of full results of the July 2012 JOGMEC deployment of the hybrid PCS offshore Japan and subsequent detailed analyses and design modification recommendations, after which available onshore test site well slot availabilities will be evaluated and a site selected.

In addition to the above activities, the final scientific results of the Gulf of Mexico JIP's 2009 "Leg II" logging-while-drilling (LWD) program were published in the Journal of Marine and Petroleum Geology, Volume #34 (June 2012). The volume, co-edited by Timothy S. Collett (USGS) and Ray Boswell (DOE-NETL), contains 15 full-length papers that detail the geophysical/geological program that guided the selection of the drill sites, describe the field operations, and report on the scientific interpretations derived from the acquired LWD data. Contributors to the papers included scientists from the National Energy Technology Laboratory, the U.S. Geological Survey, the Bureau of Ocean Energy Management, Columbia University, Schlumberger, and AOA Geophysics.

3.0 Phase III A (Leg II) Activities

Final science reports of the Leg II expedition were published in a special issue of the Journal of Marine and Petroleum Geology, Volume 34, Issue 1, (June 2012) entitled "Resource and hazard implications of gas hydrates in the Northern Gulf of Mexico: Results of the 2009 Joint Industry Project Leg II Drilling Expedition"

The 224 page volume, co-edited by Timothy S. Collett (USGS) and Ray Boswell (DOE-NETL) contains 15 full-length papers that detail the geophysical/geological program that guided the JIP selection of the drill sites, describe the field operations, and report on the scientific interpretations derived from the acquired LWD data. Contributors to the papers included scientists from the National Energy Technology Laboratory, the U.S. Geological Survey, the Bureau of Ocean Energy Management, Columbia University, Schlumberger, and AOA Geophysics.

The table of contents of the special issue is listed in Appendix 1 and copies of the special issue and papers can be found at: http://www.sciencedirect.com/science/journal/02648172/34/1.

As previously reported the original and fully processed GOM JIP Leg II well log database was loaded onto the Lamont-Doherty Earth Observatory (LDEO) web site: http://brg.ldeo.columbia.edu/ghp/. The web site also includes original and processed data in the same formats as GOM JIP Leg I. Additional Leg II data will be added whenever available, for example potential additional MP3 data from Leg II. A NETL Fire in the Ice (FITI) newsletter announcement of the availability of access to this data by researchers worldwide has resulted in a number of research proposals from professors and students.

4.0 PHASE III B (Leg III) Activities

The Cooperative Agreement is now moving toward its conclusion. The JIP and DOE have determined that they will focus full attention for the remainder of this Phase on the development and testing of an integrated suite of pressure coring and pressure core analysis devices in collaboration with research and development experts in the U.S. Department of Energy, U.S. Geological Service, Georgia Tech, Scripps Institution of Oceanography and other academic institutions as well as Aumann and Associates Inc., GeoTek and other contractors. No other drilling programs will be conducted.

4.1 Instrumented Pressure Test Cell (IPTC) and Pressure Core Characterization Tool (PCCT) Development

During the current reporting period modifications to the Instrumented Pressure Test Cell (IPTC) and construction and shop testing of the Pressure Core Characterization Tool (PCCT) were completed. In addition a joint USGS and Georgia Tech operational test of the IPTC and PCCT was held in June.

The joint operational test was an opportunity to verify fit-up and proper operation of the equipment, train operators, and improve designs. Training was provided in PCCT device disassembly and assembly. The IPTC was pressurized to 5000 psi using a new system composed of an air compressor, low- and high-pressure pumps, a main manifold, and a safety manifold. After the joint operational test:

- low-frequency acoustic crystals were incorporated in additional PCCT devices
- signal transmission capabilities of the IPTC electronics were improved
- additional ball valve, clamps, and flange were ordered
- a second manifold system has been re-designed, built, and is being tested

- a high-pressure, high-precision differential pressure transducer manifold has been sent to GT for potential hydraulic conductivity measurements

Although the joint operational test was a success, work will continue to fine-tune both devices based on lessons learned.

JOGMEC (a Gulf of Mexico Hydrate Joint Industry Project participant) and AIST (Japan National Institute of Advanced Industrial Science and Technology) organizations have collaborated to extend a very generous invitation to the JIP for USGS and Georgia Tech to conduct field trials of the IPTC and PCCT late in 2012 at the AIST national hydrate laboratory in Sapporo, Japan, analyzing some of the pressurized hydrate cores obtained by JAMSTEC using the prototype Hybrid PCS in July 2012.

This invitation represents a rare opportunity for the JIP to test these devices using naturally-occurring hydrates from deepwater marine sediments that were captured and preserved at near-in situ pressures. This unprecedented opportunity is an example of the DOE's and JIP's successes in developing advanced technical capabilities for the analysis of hydrates in sediments and leveraging them to foster international cooperation in the research of naturally occurring methane hydrates in deepwater environments.

Please refer to Appendix 2 for more details of the joint IPTC and PCCT test and schematics of the PCCT.

4.2 Pressurized Hydrate Coring System

Other than IPTC and PCCT development work, the remainder of the project during this reporting period has been in a "monitor and minimum spend" mode while awaiting the results of the July 2012 Japan deployment of the prototype Hybrid PCS for an offshore hydrate pressure coring expedition, as well as subsequent detailed technical analyses of the prototype's performance and proposal of any design modifications arising from the detailed technical analyses. Although JOGMEC's July expedition was completed with a reportedly high recovery percentage of pressurized hydrate cores from the prototype Hybrid PCS, there were indications that even better performance of the prototype might be achievable.

JOGMEC and CDEX (Center for Deep Earth Exploration) (both owners of prototype Hybrid PCSs) are planning to hold a detailed technical review and design improvement workshop at Aumann and Associates in October 2012. The JIP has also been invited to attend.

4.3 Other Activities

Several detailed JIP technical and science team meetings have been held in March and April at Aumann & Associates to discuss JIP pressure corer options. These meetings provided the attendees with an excellent understanding of the prototype Hybrid PCS design, tool options and associated costs. This information will be invaluable during the final selection process following availability of the planned October detailed analyses and design modification recommendations.

During the March 2012 meeting, pull tests were conducted on the standard prototype Hybrid PCS basket-type core catcher to address concerns by some in the science community that the basket core catcher wasn't strong enough to hold core without inverting. The tests proved that under normally expected loadings the basket catcher works properly. Please refer to Appendix 3 for details.

Three options for coring service van were generated and evaluated. Options included a non-standard 33' service van length (similar to that currently used by Aumann & Associates), a 40' ISO standard length service van with capability to be cut down to 33' if needed in the future, and a fully utilized 40' ISO standard length service van. Final selection will be made after availability of full results of the July 2012 JOGMEC deployment of the hybrid PCS offshore

Japan and subsequent detailed analyses and design modification recommendations. This approach is deemed prudent because some of the JIP Hybrid PCS components might be longer than 33 feet, depending on the configuration chosen.

Three options for onshore test sites were also evaluated including visits to two of the sites. Cost and technical information was collected and evaluated. Final selection will be made after detailed analyses and design modification recommendations are available for the prototype Hybrid PCS used by JOGMEC during the July 2012 hydrate pressure coring expedition. Once this information is available an updated review of the onshore test sites will be conducted to determine which will have suitable well slot availability in the required timeframe.

5.0 Conclusions

The Cooperative Agreement is now moving toward close-out. The JIP and DOE have determined that they will focus full attention on the development and testing of an integrated suite of pressure coring and pressure core analysis devices with research and development experts in the U.S. Geological Service, Georgia Institute of Technology Tech, Aumann and Associates Inc., GeoTek and other academic institutions and contractors. No other drilling programs will be conducted.

During the current reporting period modifications to the Instrumented Pressure Test Cell (IPTC) and construction and shop testing of the Pressure Core Characterization Tool (PCCT) were completed. In addition a joint USGS and Georgia Tech operational test of the IPTC and PCCT was held in June in order to verify fit-up of the devices, integration of operations and training of personnel. These tests were successful. Due to a very generous invitation by JOGMEC and AIST, field trials of these devices analyzing some of the deepwater pressurized hydrate cores obtained by JOGMEC's prototype Hybrid PCS in July 2012 are tentatively planned to take place potentially late in 2012 at the AIST national hydrate laboratory in Japan.

Other than IPTC and PCCT development work, the remainder of the project is in a "monitor and minimum spend" mode while awaiting the results of the July 2012 Japan deployment of the prototype Hybrid PCS during an offshore hydrate pressure coring expedition, subsequent detailed technical analyses of the prototype's performance, and any design modification recommendations arising from the detailed technical analyses. Although JOGMEC's July expedition was completed with a reportedly high recovery percentage of pressurized hydrate cores from the prototype Hybrid PCS, there were indications that even better performance of the prototype might be achievable.

6.0 References

No external references were used for this report.

Appendix 1: Marine and Petroleum Geology Special Volume.

"Resource and hazard implications of gas hydrates in the Northern Gulf of Mexico: Results of the 2009 Joint Industry Project Leg II Drilling Expedition"

Volume 34, Issue 1, Pages 1-224 (June 2012)
Edited by Timothy S. Collett and Ray Boswell

Link: http://www.sciencedirect.com/science/journal/02648172/34/1

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Appendix 2: Joint IPTC and PCCT Fit-up, Testing and Operations, and PCCT Schematics.

Figure 1 Instrumented Pressure Testing Chamber (IPTC) showing probe ball valves, drive arms, and the ends of the instrumented probes

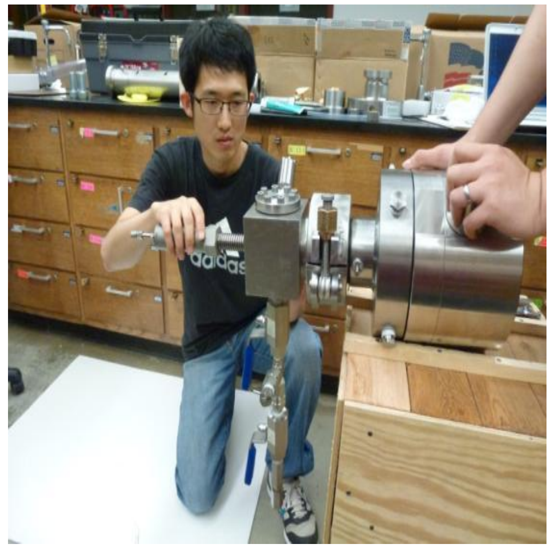

Figure 2 Junbong Jang making an adjustment on the Bio-Sampler. A core ball valve is attached to the right side of the Bio-Sampler

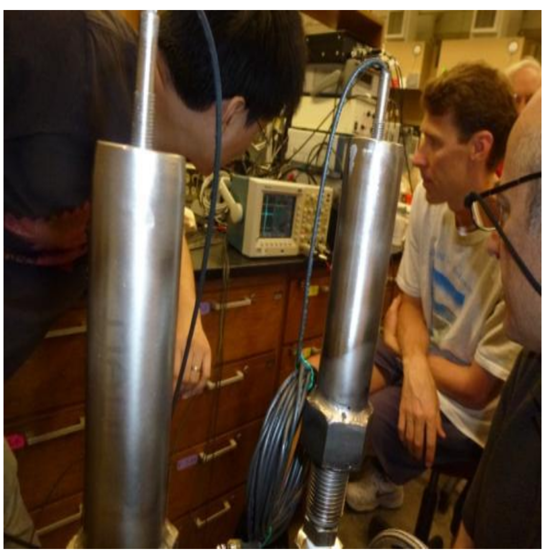

Figure 3 Calibration check of the IPTC during June 2012 operations at GT

Figure 4 Dave Mason pressure testing a new manifold system

Figure 5 Instrumented Pressure Testing Chamber (IPTC) showing probe ball valves, drive arms, and the ends of the instrumented probes

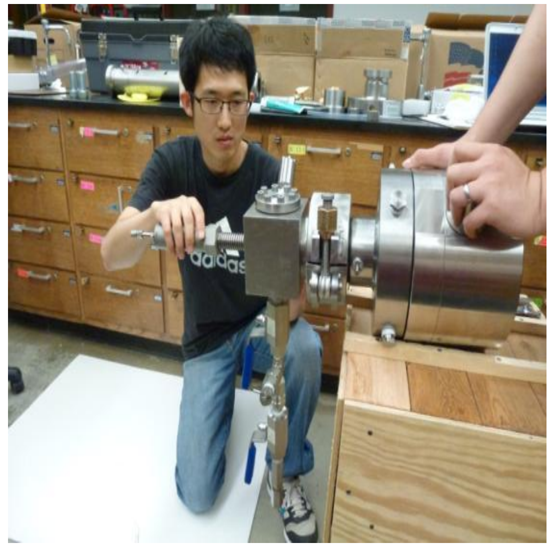

Figure 6 Junbong Jang making an adjustment on the Bio-Sampler. A core ball valve is attached to the right side of the Bio-Sampler

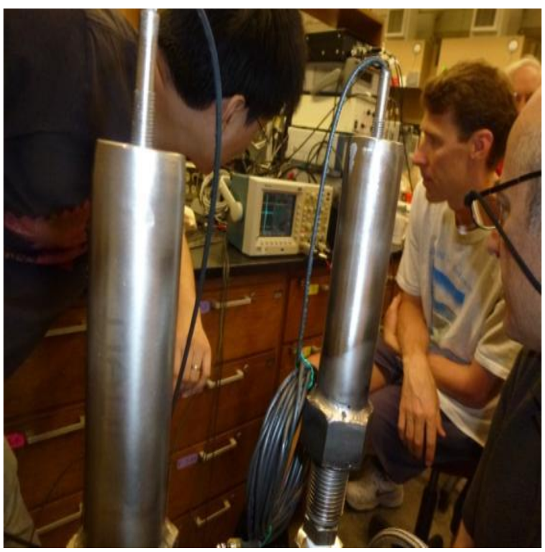

Figure 7 Calibration check of the IPTC during June 2012 operations at GT

Figure 8 Dave Mason pressure testing a new manifold system

Figure 9 Manipulator string used to precisely move a core section through the IPTC

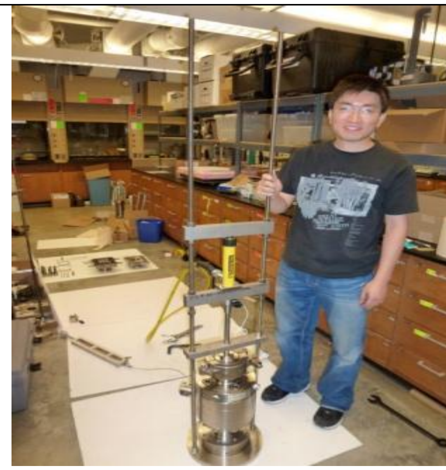

Figure 10 Sheng Dai, standing next to the Effective Stress Cell

Figure 11 Marco Terzariol tightening a component on the Direct Shear Cell

Figure 12 Depressurization System holds core. Water and gas collect in small and large clear containers.

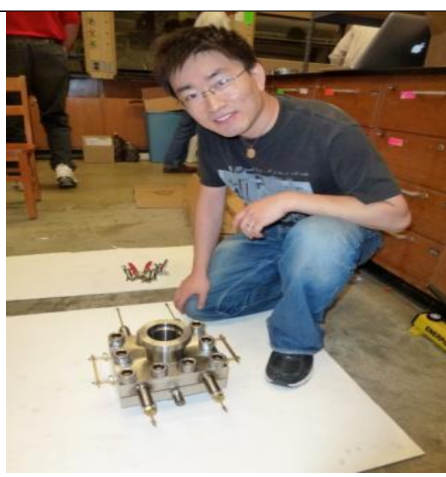

Figure 13 Sheng Dai kneeling next to one of the cutter designs

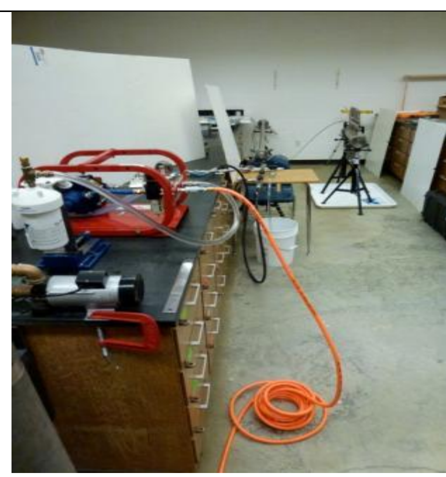

Figure 14 Pressuring the IPTC in Atlanta using a new pump and manifold system

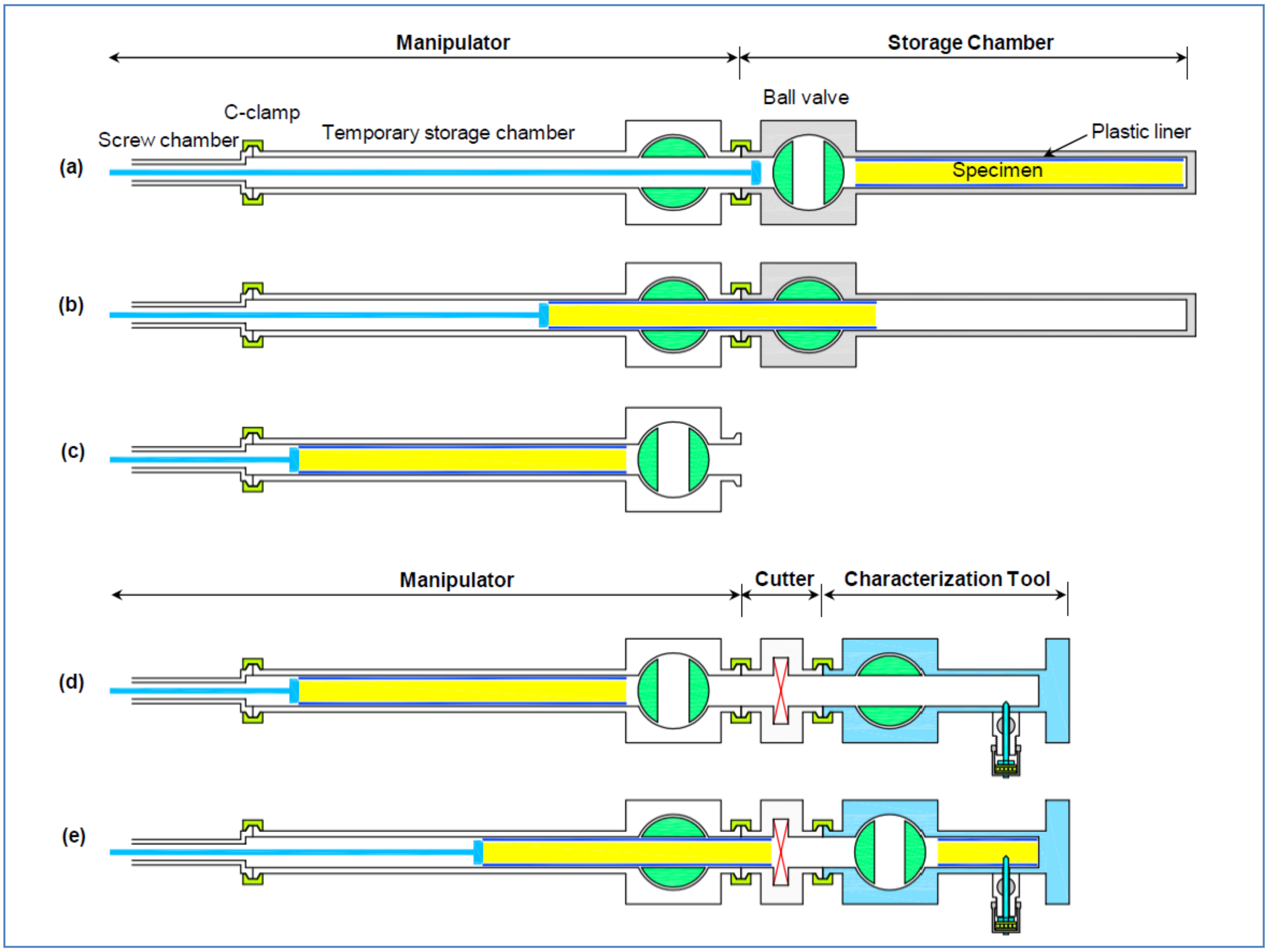

Figure 15 Pressure core manipulation.

(a) The manipulator MAN couples with the storage chamber and fluid pressures are equalized at the target pressure p0 before opening the ball valve.

(b) The manipulator captures the core and transfers it into the temporary storage chamber.

(c) Ball valves are closed and the depressurized storage chamber is separated.

(d) The selected characterization tool is coupled to the manipulator and is pressurized to p0.

(e) Ball valves are opened and the core is pushed into the characterization tool; stand-alone characterization tools may be detached after retrieving the rest of the core and closing valves. Note: the cutter tool CUT is shown in panes.

(d and e); it is attached in series to cut core to any desired length to meet tool requirements (for stand-alone ESC, DSC, CDP, and Bio tools).

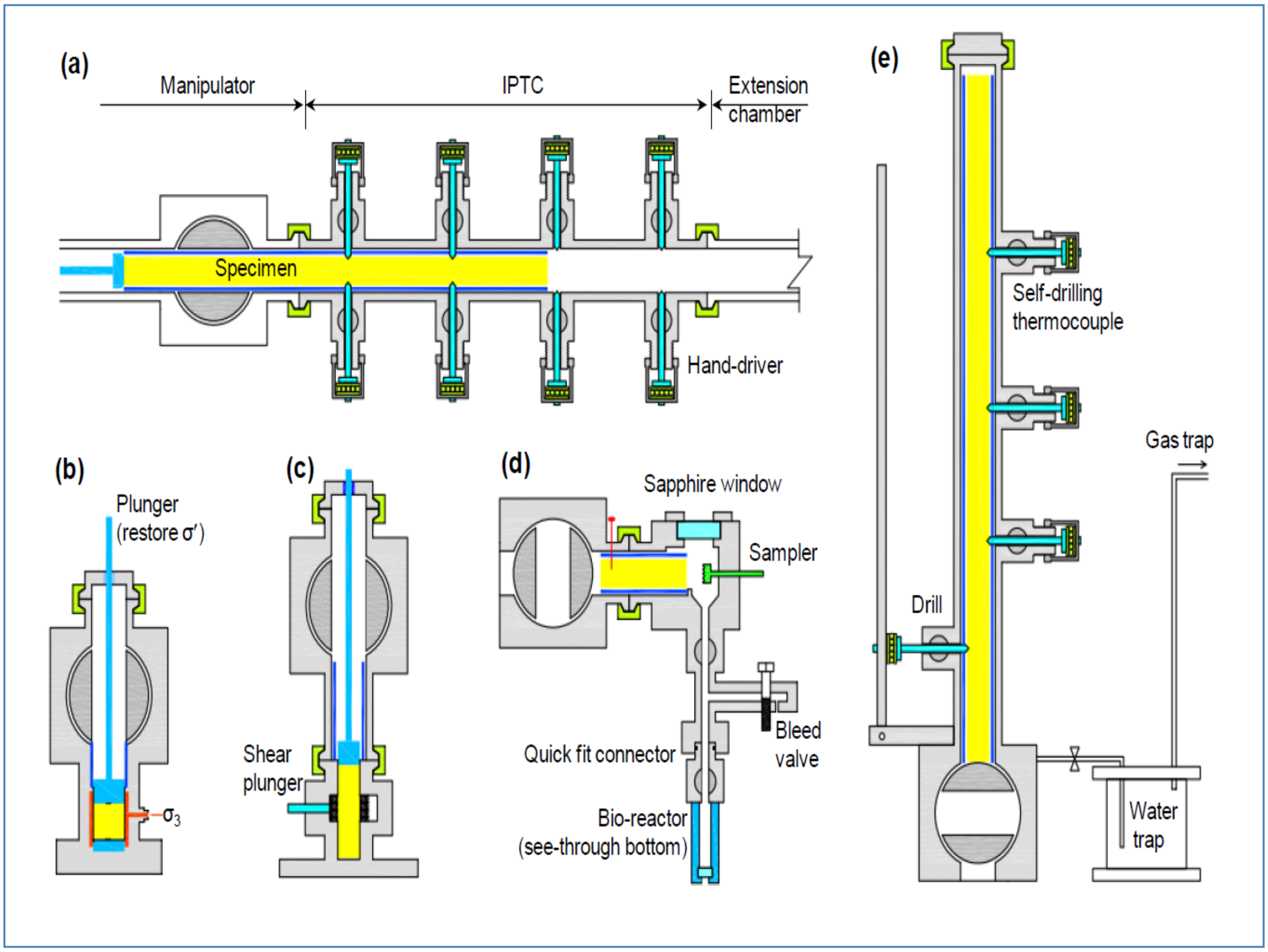

Figure 16 Schematic diagrams of characterization chambers.

(a) IPTC instrumented pressure testing chamber with P-T control.

(b) ESC effective stress chamber with σ'-P-T control.

(c) DSC direct shear chamber with σ'-τ-P-T control.

(d) CDP controlled depressurization chamber for sediment preservation and gas production.

(e) BIO sampler for multiple bio-reactor chambers.

Scale: the outside diameter of the large ball valve shown in all devices is OD = 220 mm

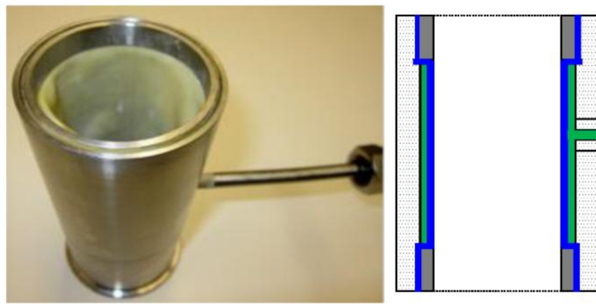

Figure 17 Flexible wall boundary condition.

Lateral effective stress can be independently applied through a flexible wall membrane gadget (ID = 63.5mm, H = 150mm). This device allows the implementation of triaxial test conditions, and prevents preferential flow paths along the interface for fluid conductivity studies.

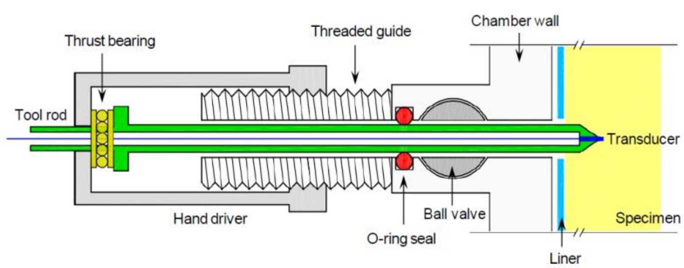

Figure 18 Tool Control.

The displacement of sensors, subsampling tools and drills are controlled under pressure using a screw-based positioning system where the driver advances along the threaded guide while pushing the tool rod (shown in green). Transducers at the tip of the rod are wired through the central hole in the tool rod.

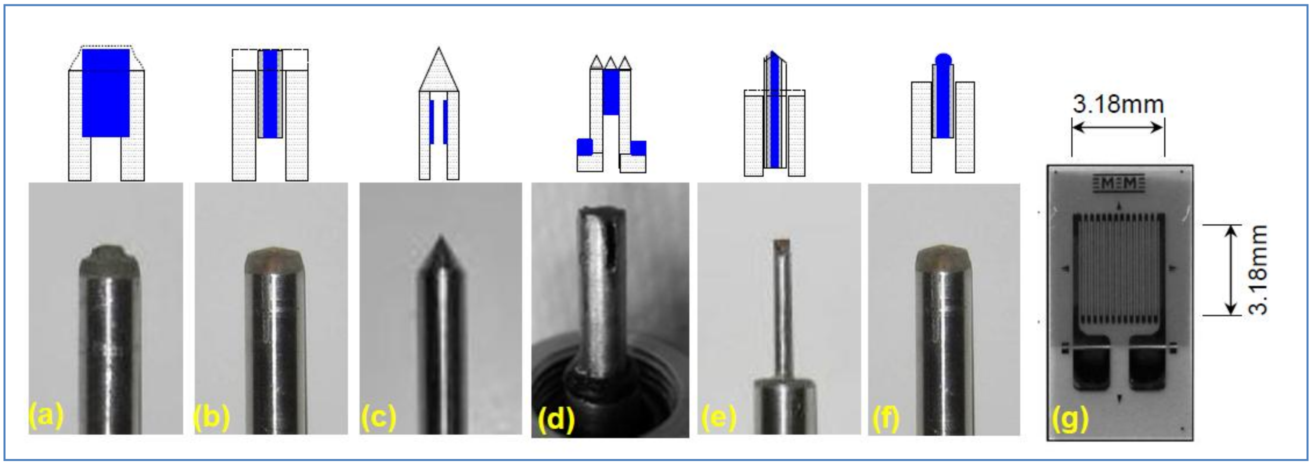

Figure 19 Measurement tools and sensors.

(a) Bender elements for S-wave generation and detection.

(b) Piezocrystals for P-waves.

(c) Penetrometer for strength measurement.

(d) Pore fluid sampler.

(e) Electrical needle probe for resistivity profiling.

(f) Thermocouple instrumented tip.

(g) Strain gauge for thermal conductivity determination (TPS – NETL; Rosenbaum et al., 2007).

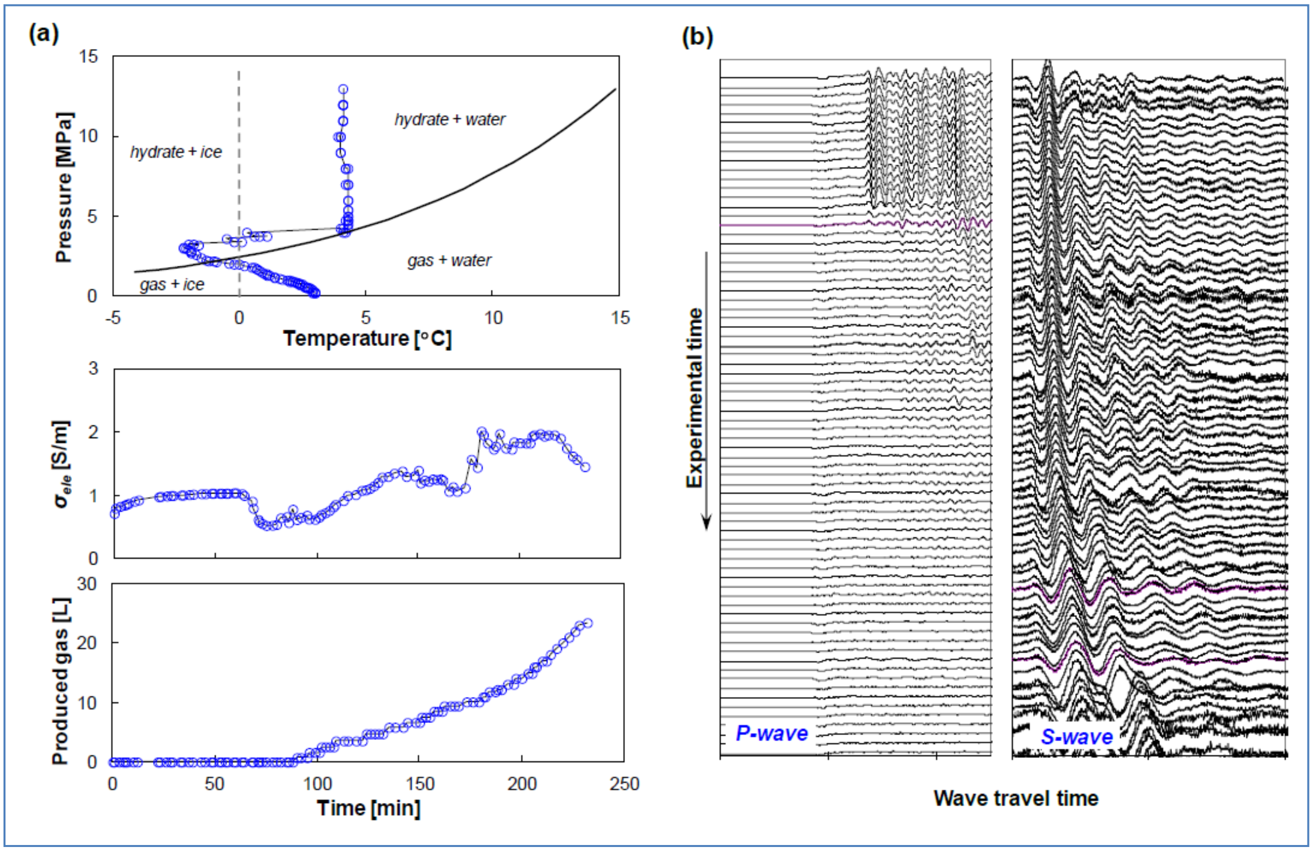

Figure 20 Monitored gas production tests using IPTC

1. **Evolutions of pressure, temperature, electrical resistivity, and produced gas (Krishna-Godavari Basin, Yun et al., 2010);**

(b) Typical wave signatures during gas production: P-wave signatures eventually fade

Appendix 3: Core Liner Basket Catcher Pull Test

Report on core basket catcher and core liner to core catcher connection test

Science Team: DOE (Boswell), USGS (Collett)
JIP: Project Manager (Balczewski), Coring Expert (Fate)
Contractors: Aumann & Associates (Aumann)
March 16, 2012

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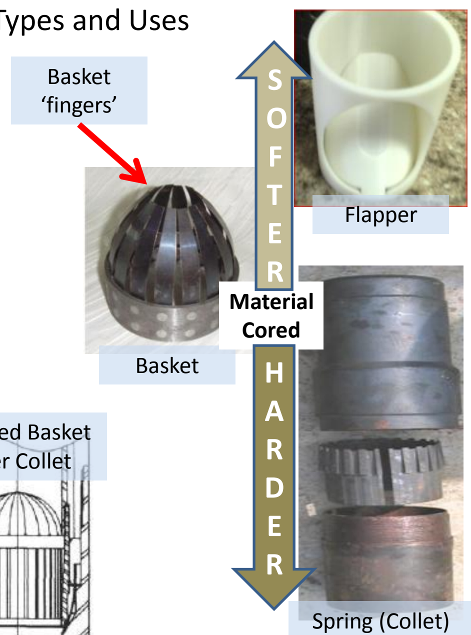
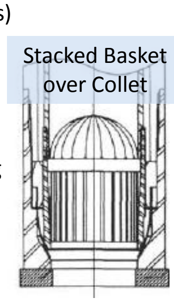
Core Catcher Types and Uses

- A core catcher has two functions: To break the core off the bottom of the hole, and to hold the core in the inner barrel while coming out of the hole.
- The are three main types of catchers:
  - Toggle or Flapper (soft sediments)
  - Basket with fingers (medium to hard sediments)
  - Collet or Spring type- slip catcher (rock)
- Core catchers can often be combined (stacked) or changed between coring runs depending on the characteristics of the formation currently being cored.





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Report on May 16th basket catcher and core liner test

- Some members of the science team felt that a basket core catcher and the threaded end of the plastic core liner it connects to may not be strong enough for coring the type of cemented sand hydrate reservoirs discovered in JIP Leg II. Concerns:
  - The basket 'fingers' may not be able to break off cemented sand hydrate core at the start of retrieval (concern that the fingers would not grip strongly enough).
  - The basket 'fingers' may not be robust enough to support the weight of a 3.5m long cemented sand and hydrate core during recovery (concern that the fingers would invert and let the core fall out)
  - The threaded connection between the basket-type core catcher and the plastic core liner was perceived as a weak point in the plastic liner with potential for the liner to break off from the core catcher under normal operating conditions.

- A test was held on May 16th to determine if the standard Aumann & Associates basket-type core catcher and the plastic core liner threads would be suitable for coring JIP Leg II-type hydrates. Test procedures and results are shown on the following pages.

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Pull tests using plaster as a cemented hydrate core substitute

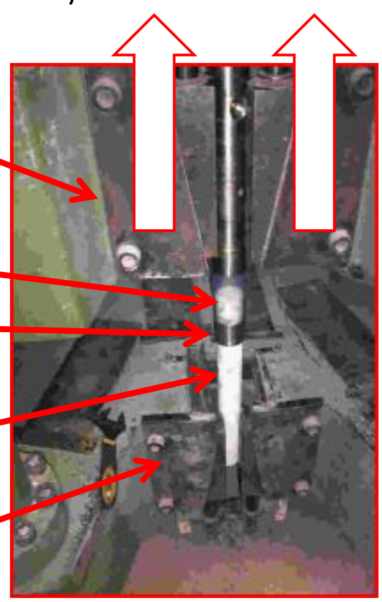
Hydraulic Pull Testing Machine. Top jaws pull up on the HPCS inner tube plug with plastic core liner and basket core catcher attached and plaster core inside.

Plastic core liner

Standard Aumann & Associates basket catcher

Plaster core (note, before each test the plaster core was pushed into the core catcher from the bottom to simulate normal coring operations

Lower jaws hold plaster core.



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Tests and Data

Test #1: Pulling at a slow, constant rate recorded a 13 MPa (1910 lb) resistance, no core breakage and liner threads held. Doubled the pull speed for the last 2 minutes and resistance went to 24 MPa (3510 lb) (high value is an artifact of the machine). No core breakage but some slippage even with teeth digging into plaster.

Test #2: Used a file to create a rough surface on the core. Pulled at a slow constant rate, recorded a 14 MPa (2050 lb) resistance, no core breakage but again some slippage with teeth digging into plaster.

Test #3: Cut a deep groove in the core to catch the basket fingers and test for breaking the core. Pulled at a slow constant speed, resistance went to 33 MPa (4800 lbs), but no core breakage. Since the groove prevented scraping, the fingers eventually deformed by curling of the finger tips.

Test #4: The existing groove was enlarged. Pulled at a slow, constant speed, resistance went to 19 MPa (2760 lbs) but no core breakage. The catcher fingers were almost bent in half, but the basket itself did not invert

Plaster Core
Note vertical scrapes where basket fingers dug in deeply to keep the core from pulling out

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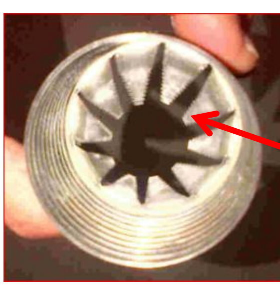
Preliminary Conclusions

- Test used a plaster core to mimic a worst case core: a fine grain sand completely cemented to rock-like hardness by hydrates and having an exceptionally smooth surface.
- The catcher is strong enough to hold the core in the barrel.
- The threaded part of the plastic sleeve is strong enough (high tensile strength) to hold the core and catcher without failing.
- Deformation of the catcher did not occur until a deep groove was cut into the core and high pulling force was applied.
- The basket catcher may not be suitable for breaking off very hard hydrate cemented cores unless there is interbedding, microfractures, etc. A combination of catchers may be optimal.

For test #3 a deep groove was cut in the plaster core to grab basket catcher fingers and measure force required for failure.



Failure in test #3 occurred at 33 MPa (4800 psi), with failure due to finger tip bending (not compete basket inversion).

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Appendix 4: Project Timeline

	2012				2013			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
Pressure Corer Development Program								
Slim Pressure Corer Design Requirements & Options								
Slim Pressure Corer Recommendation & Approval								
Prototpe Hybrid PCS Field Expedition (Japan)								
Technical Review and Design Improvement Meeting								
Slim Pressure Corer Fabrication and Shop Test								
Onshore Test								
Inventory and DOE Turnover								
IPTC & PCCT Pressure Core Laboratory Tools Program								
Combined System Laboratory Calibration & Testing								
IPTC & PCCT Field Test (Japan)								
Inventory and DOE Turnover								
Science Program								
Science Team Assistance in Final Reporting								
Reporting								
Leg I-III Final Reports								
DOE Project Close-out								

Notes:

1) Prototype Hybrid PCS fabrication start is likely to be January 2013 due to prior commitments of Aumann & Associates.
2) The mid-October scheduling of the JOMEC and CDEX detailed design review of prototype Hybrid PCS performance and development of recommended modifications has unfortunately delayed the final JIP Board approval of the 2013 science program until December 2012.

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