Gulf of Mexico Gas Hydrate Joint Industry Project: Overview of Leg II LWD Results

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Gulf of Mexico Gas Hydrate Joint Industry Project

JIP Members

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## JIP Executive Board
- Emrys Jones – Chevron
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- Patrick Hooyman – Schlumberger
- Matt Frye – BOEMRE
- Ken’ichi Yokoi – JOGMEC
- I.L. Budhiraja – Reliance Industries Ltd
- Hong-Geun Im – Korea National Oil Corporation
Areas with Seismic Indications of Gas Hydrate
> 100 identified thus far

Shedd et al. 2009
Gulf of Mexico Gas Hydrate JIP Leg II
April 16 – May 5, 2009

• Objectives
  – extend knowledge to sand systems
  – high-grade sites for Leg III coring
  – calibrate of seismic GH detection
  – inform the BOEMRE assessment
  – advance GH program protocols
  – test alternative exploration models

• Expedition design
  – accept high geologic risk
  – maximize sites/models tested
  – 20 sites permitted
  – real-time decision-making
  – $11.2 million LWD program
Gulf of Mexico Gas Hydrate JIP
Q4000 MODU, MV Mia, ROV Venom
JIP Leg II featured a state-of-the-art bottom hole assembly

- 23.2’ x 8.375” SonicVision
- 18.3’ x 7.5” PeriScope
- 32’ x 8.25” TeleScope
- 25.2’ x 8.25” EcoScope
- 10’ x 8.25” GeoVision
- 6.75” x 8.25” Hole opener
- 31’ x 6.5” OD MP3 (SonicScope)
- 6.75” PDC bit

LWD tools by Schlumberger

There were no tool failures requiring retrieval of the drill string on JIP Leg II
MWD/LWD Datasets
### GOM JIP Leg II: Well Sites

**21 days – 3 sites – 7 holes – 15,300’ section**

<table>
<thead>
<tr>
<th>Hole</th>
<th>API Number</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Water Depth (feet)</th>
<th>Water Depth RKB (ft)</th>
<th>Total Depth of Hole RKB (ft)</th>
<th>Total Depth of Hole Below Seafloor (ft)</th>
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</thead>
<tbody>
<tr>
<td>AC 21 A</td>
<td>608054007000</td>
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<td>94° 54' 00.8545&quot;</td>
<td>4889</td>
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<td>6700</td>
<td>1760</td>
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<tr>
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<td>26° 56' 40.3922&quot;</td>
<td>94° 53' 36.4053&quot;</td>
<td>4883</td>
<td>4934</td>
<td>6050</td>
<td>1116</td>
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<tr>
<td>GC 955 H</td>
<td>608114053700</td>
<td>27° 00' 03.2836&quot;</td>
<td>90° 25' 35.4475&quot;</td>
<td>6670</td>
<td>6721</td>
<td>8654</td>
<td>1933</td>
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<tr>
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<td>6822</td>
<td>9027</td>
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<td>27° 00' 08.5611&quot;</td>
<td>90° 26' 12.0500&quot;</td>
<td>6516</td>
<td>6567</td>
<td>8078</td>
<td>1511</td>
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<tr>
<td>WR 313 G</td>
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<td>26° 39' 48.7355&quot;</td>
<td>91° 41' 02.3996&quot;</td>
<td>6562</td>
<td>6614</td>
<td>10200</td>
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<tr>
<td>WR 313 H</td>
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<td>6501</td>
<td>9770</td>
<td>3269</td>
</tr>
</tbody>
</table>
Gulf of Mexico JIP Leg II
April 16 – May 5, 2009

AC21 GC955 WR313 GC195
Walker Ridge 313 – Terrebonne Basin

<table>
<thead>
<tr>
<th>Garden Banks</th>
<th>Green Canyon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keathley Canyon</td>
<td>Walker Ridge</td>
</tr>
</tbody>
</table>

Terrebonne Basin

New Orleans

Galveston
Pre-Drill Seismic Prediction
gas hydrate saturation

Hutchinson et al. 2009
WR 313 LWD Results

Strata-Bound Fracture Filling Gas Hydrate

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Shedd et al. 2010
Walker Ridge 313 LWD Results

“blue” unit

DOWN-DIP (G – well)

UP-DIP (H – well)
Walker Ridge 313 LWD Results

“orange” unit

WR313-H

Cook et al. 2009
WR 313 – Orange Sand
Gas Hydrate Saturation
Additional WR 313 GH Occurrences

*Pore-filling in sands*

- **Shallow Sands**
  - Numerous thin sands
  - High saturation
  - Virtually all sands filled
  - Up to 1,500’ above the BGHS

- **Stratigraphically-deeper horizons**
  - Sand occurrence in “green” unit confirmed
  - High probability that all phase reversals observed = GH-filled sands
Additional GH Occurrences – WR 313
Fracture-filling in shallow muds

- Occurrence
  - Seen in both JIP wells
  - About 500’ thick
  - Sgh elevated, but uncertain
  - Stratal bound
  - No clear seismic manifestation
  - Origin unclear

- Log Response
  - Fracture forms observable on azimuthal resistivity data
  - Anisotropic resistivity

Cook et al. 2010
GC 955 Site Elements

Green Canyon 955
- Sand reservoir
- Source
- Migration pathways (blocked?)
- Closure
- Seal

Faulted Four-way closed structure
Potential Sand-prone interval
Proximal
Distal

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GC 955 Targets

Strong “leading peak” amplitudes

GC955-Q  GC955-H
GR  RES  GR  RES

McConnell et al. 2010
Green Canyon 955-H LWD Results

McConnell et al. 2010

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Green Canyon 955-H LWD Results
Complex faulted channel-levee system
Green Canyon 955-H LWD Results

~100’ of GH in sand

Guerin et al. 2009
Green Canyon 955-H Results
Both fracture/mud and pore-fill/sand modes

Guerin et al. 2010
Green Canyon 955-H Results
Complex geologic controls

- 88 ft
- 9 ft
- 4 ft
AC 21 Site Elements
Prior evidence of shallow, resistive sand

Frye et al. 2010

1995 “Rockefeller” 2 ohm-m RES
Alaminos Canyon 21
Regional shallow sand target

Frye et al. 2010
Alaminos Canyon 21 – Sand Model

North Entry

East Entry

Salt

Salt

Salt

Salt

JIP site AC 21

JIP site EB 992

Frye et al. 2010
Alaminos Canyon 21 Results
consistent 2 ohm-m resistivity

AC21-A
GR RES

AC21-B
GR RES

Frye et al. 2010
AC 21 LWD Results
low-to-moderate, but uncertain, Sh

Gas Hydrate Saturation potentially 20% to 40%
• Significant accumulations of high concentration GH in sand reservoirs in the GOM
• BOEMRE assessment model results validated
• Assessment with LWD tools excellent, cores required to answer many questions
• Pre-drill identification from seismic reliable for select accumulations
• GH can occur throughout the section
• GH occurrence appears controlled often by reservoir conditions
• Controls/occurrence at BGHS may be complex
JIP Leg II – Implications

• Gas hydrate R&D
  – 1,000’ deeper than any previous research well

• Full data collection from LWD

• Gas hydrate confirmed in sand reservoirs at multiple sites
  – Excellent research sites for further data acquisition defined

• Confirmation of research approach
  – focus on the reservoir (hydrates in sands)
  – “direct” detection
  – use/tailor existing hydrocarbon exploration concepts
Gulf of Mexico JIP – Next Steps

• Leg II Data analysis and Reporting
  – JMPG Special Volume 2012
  – Integrate with existing and new datasets (ex. CSEM)
  – Initial results reports at DOE/NELT website

• Leg III preparations
  – Spring 2012
  – Additional LWD
  – Pressure coring with new device
    • Longer (3-meters)
    • Deeper water
Anticipated Leg III
possible coring targets + timeframes
Gulf of Mexico Gas Hydrate Joint Industry Project Leg II:
LWD Methods

Introduction
The downhole logging program during JIP Leg II was designed to assess the distribution and concentration of gas hydrates below the seafloor in the Gulf of Mexico. Six LWD tools were developed for the Leg II program. Five tools were designed to log hydrate stability, and a sixth tool was designed to log hard-rock drilling properties (MacKenzie et al., 2006). The LWD tools used during JIP Leg II were the MP3 (multipole acoustic - recently commercialized under the name SonicScoop), geoVISION (electrical imaging), EcoScope (propagation resistivity, density and neutron).

www.netl.doe.gov/MethaneHydrates/JIPLegII-IR

Technical Overview (Boswell et al.)
Operational Summary (Collett et al.)
LWD Methods (Mrozewski et al.)
GC955, WR313 G&G Summary (McConnell et al.)
GC955, AC21 LWD Operations-Analysis (Guerin et al.)
WR313 LWD Operations-Analysis (Cook et al.)
AC21 G&G Summary (Frye et al.) also OTC
WR313, GC955 Site Selection (Hutchinson et al.)
AC21 Site Selection (Shedd et al.)
References


References (continued)


