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

Chevron

NETL

USGS
science for a changing world

Gas Hydrate Resource Evaluation

JIP Members

Statoil

TOTAL

ConocoPhillips

Schlumberger

KNOC Korea National Oil Corporation

HALLIBURTON

Reliance Petroleum Limited
Refining life. Redefining growth

JOGMEC

Participating Groups

SCRIPPS INSTITUTION OF OCEANOGRAPHY UCSD

RICE

LAMONT-DOHERTY EARTH OBSERVATORY
THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

Georgia Tech

AOA Geophysics Inc.

Aumann & Associates

NRL

WesternGeco

GEO TEK

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Site Selection

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JIP Leg II Field Operations

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Matt Frye, Bill Shedd – BOEMRE
Rebecca Dufrene, Paul Godfriaux – BOEMRE
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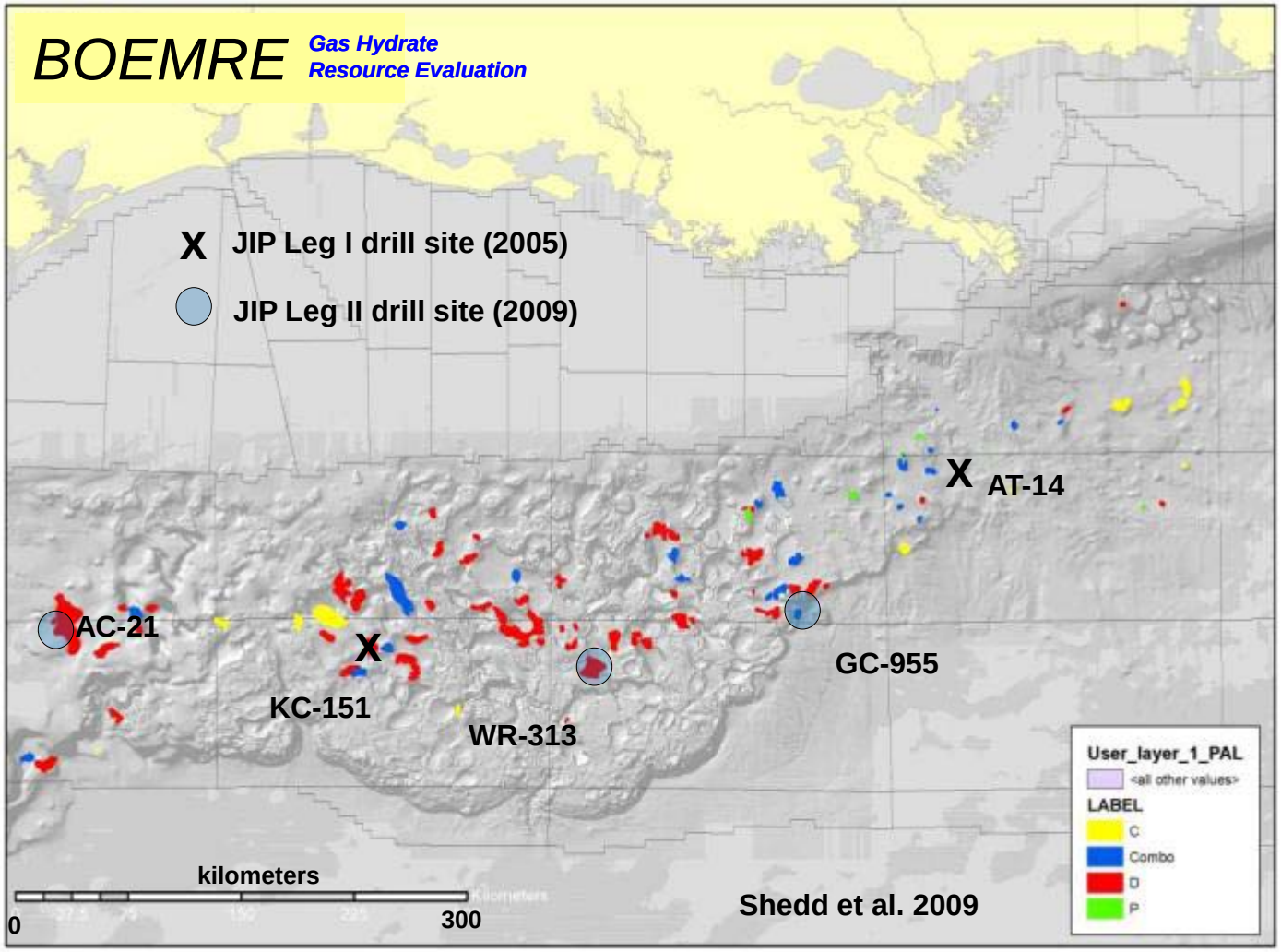
Phillippe Remacle – Total E&P USA
Patrick Hooyman – Schlumberger
Matt Frye – BOEMRE
Ken'ichi Yokoi – JOGMEC
I.L. Budhiraja – Reliance Industries Ltd
Hong-Geun Im – Korea National Oil Corporation

Areas with Seismic Indications of Gas Hydrate

> 100 identified thus far



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

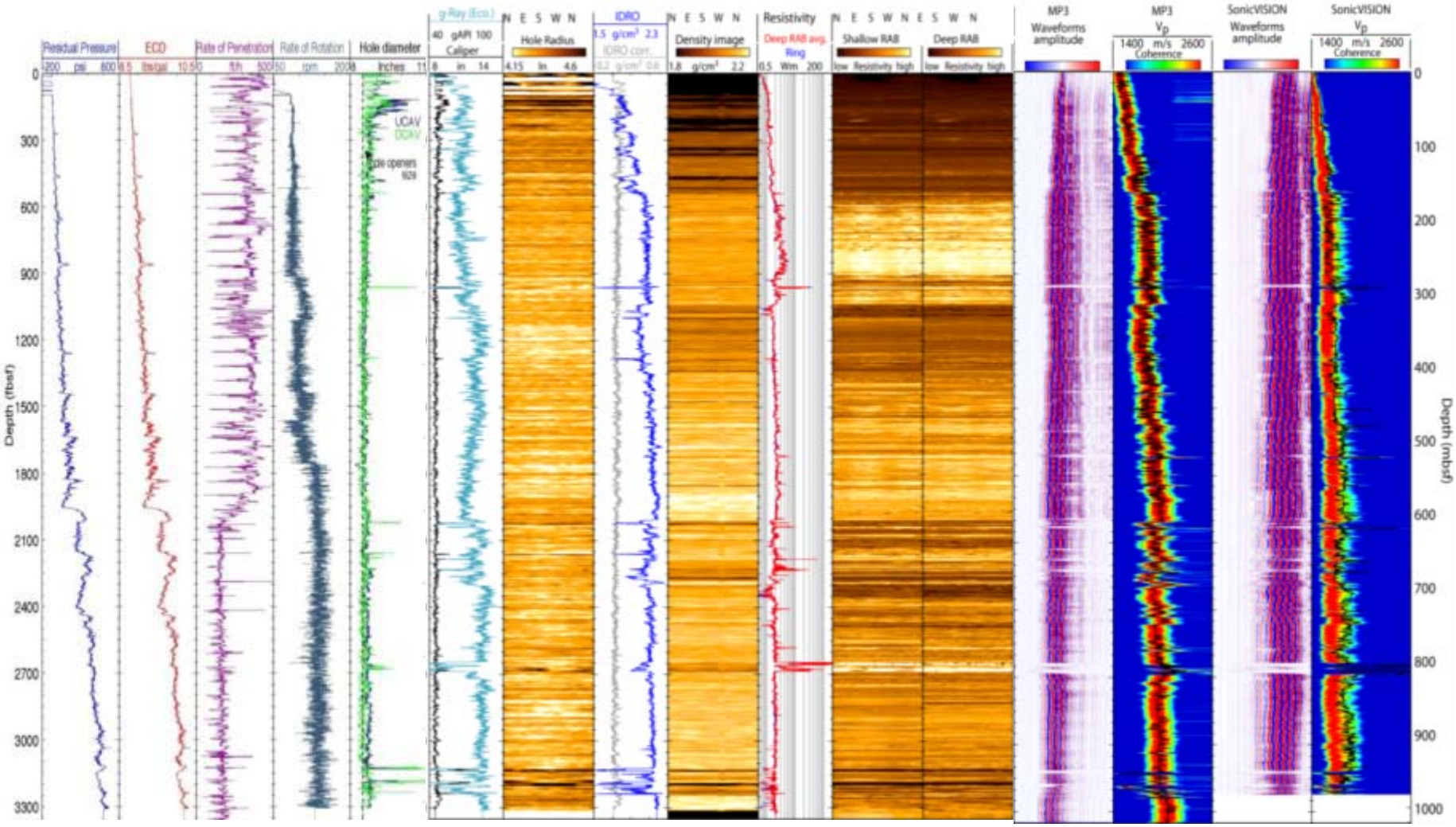
JIP Leg II featured a state-of-the-art bottom hole assembly

- 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



8

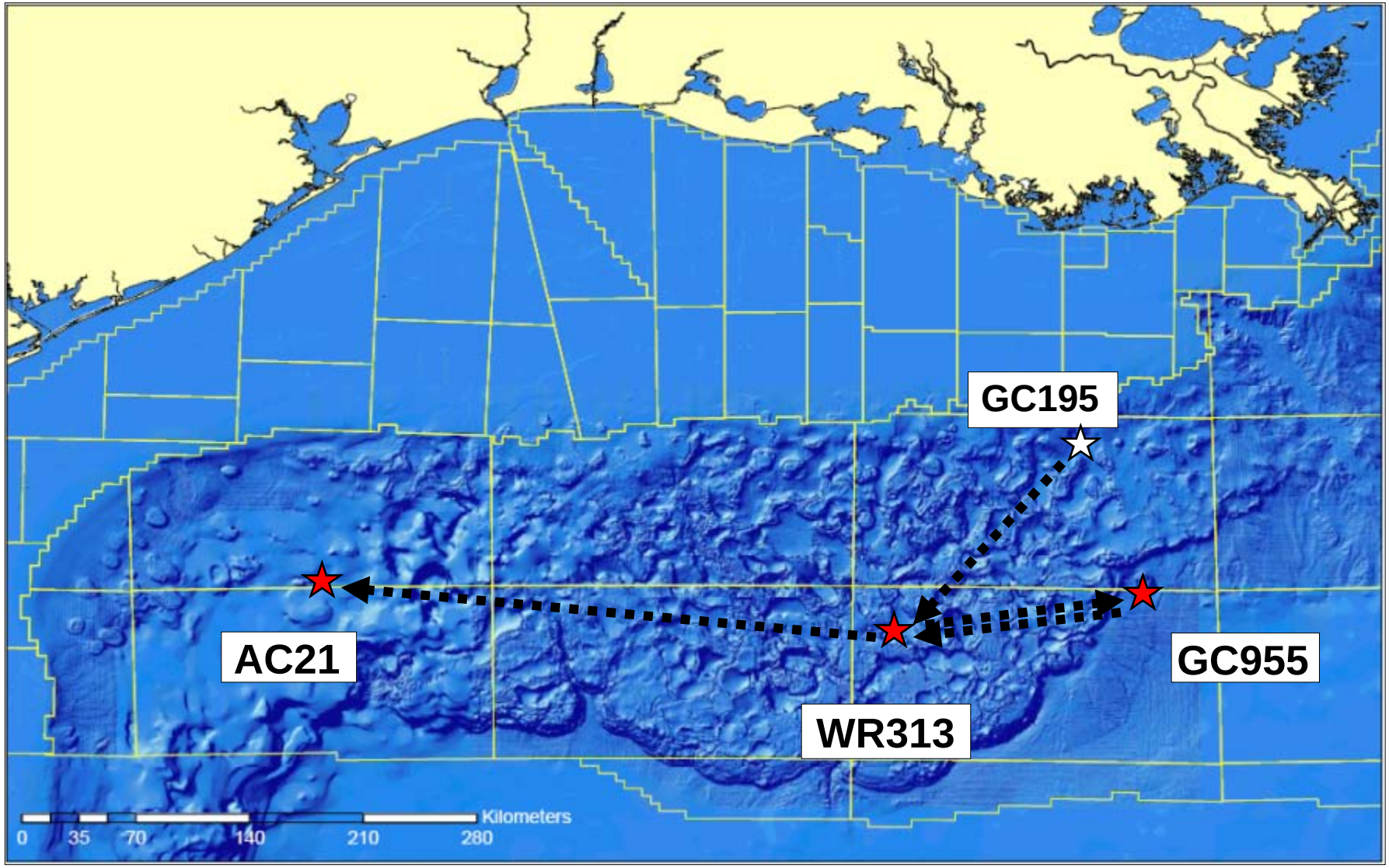
GOM JIP Leg II: Well Sites

21 days – 3 sites – 7 holes – 15,300' section

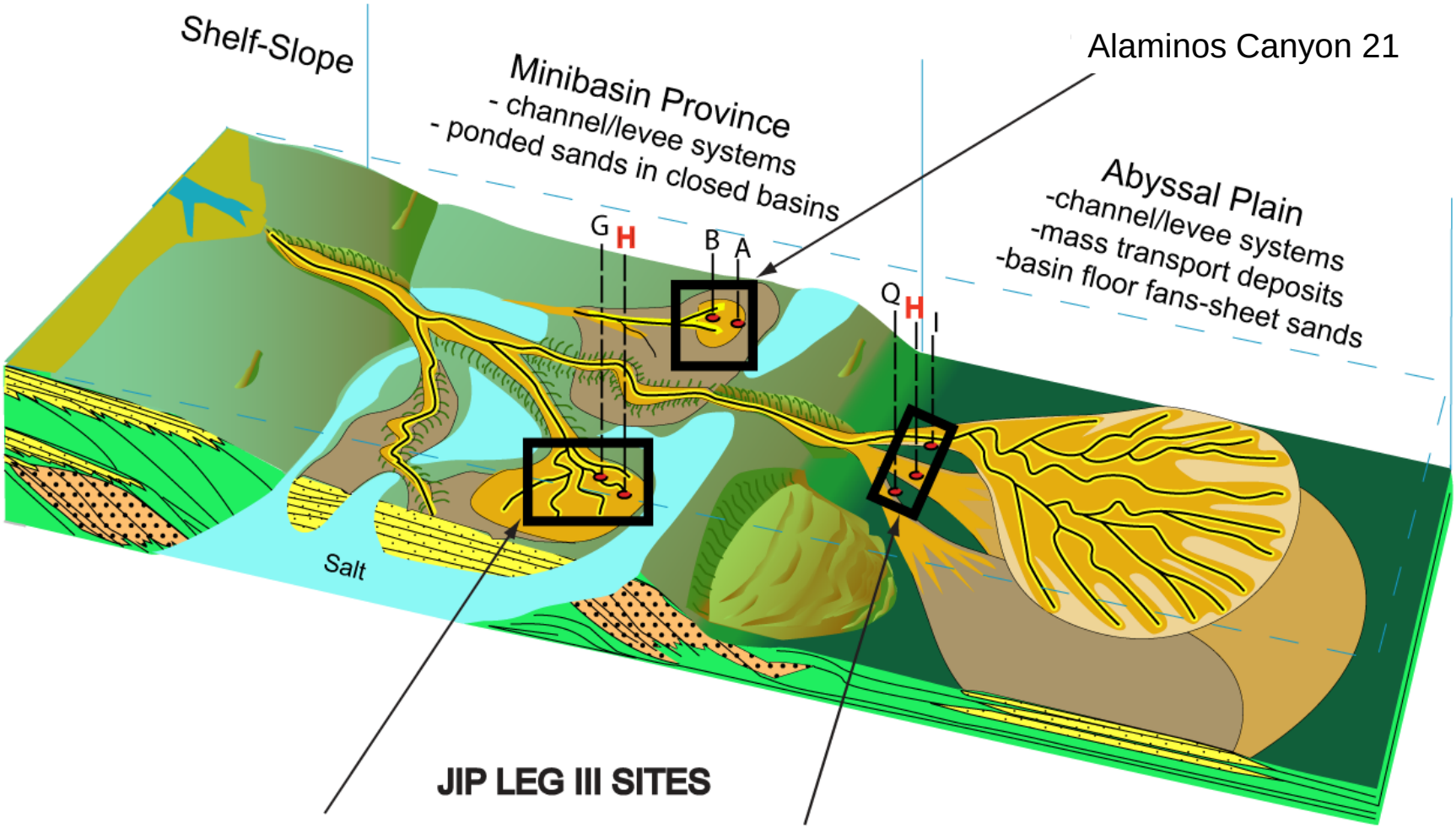
Hole	API Number	Latitude	Longitude	Water Depth (feet)	Water Depth RKB (ft)	Total Depth of Hole RKB (ft)	Total Depth of Hole Below Seafloor (ft)
AC 21 A	608054007000	26° 55' 25.0550"	94° 54' 00.8545"	4889	4940	6700	1760
AC 21 B	608054007100	26° 56' 40.3922"	94° 53' 36.4053"	4883	4934	6050	1116
GC 955 H	608114053700	27° 00' 03.2836"	90° 25' 35.4475"	6670	6721	8654	1933
GC 955 I	608114054400	27° 01' 00.7414"	90° 25' 17.2257"	6770	6822	9027	2205
GC 955 Q	608114054300	27° 00' 08.5611"	90° 26' 12.0500"	6516	6567	8078	1511
WR 313 G	608124003900	26° 39' 48.7355"	91° 41' 02.3996"	6562	6614	10200	3586
WR 313 H	608124004000	26° 39' 46.0997"	91° 40' 34.2051"	6450	6501	9770	3269

Gulf of Mexico JIP Leg II

April 16 – May 5, 2009



Leg II Sites Schematic



Modified with permission (Kendall 2006)

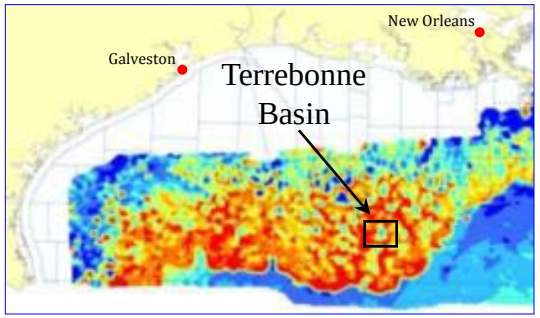
Walker Ridge 313 – Terrebonne Basin

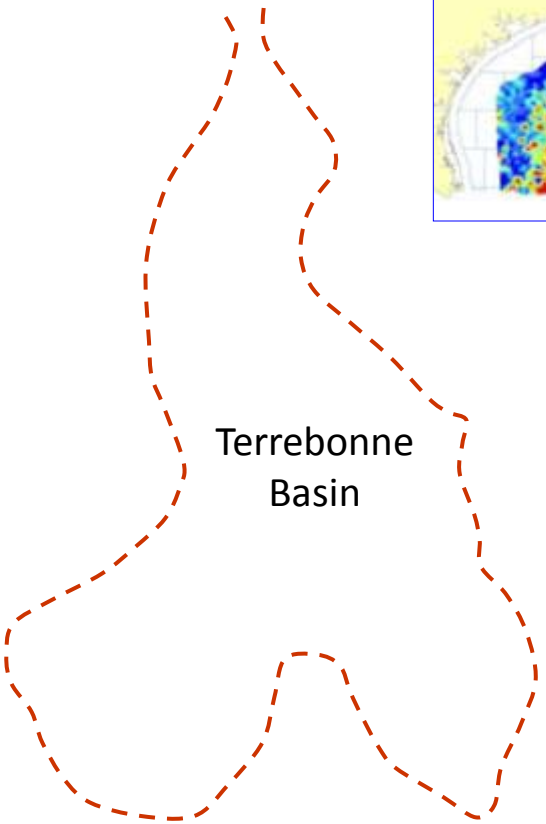
Garden Banks

Green Canyon

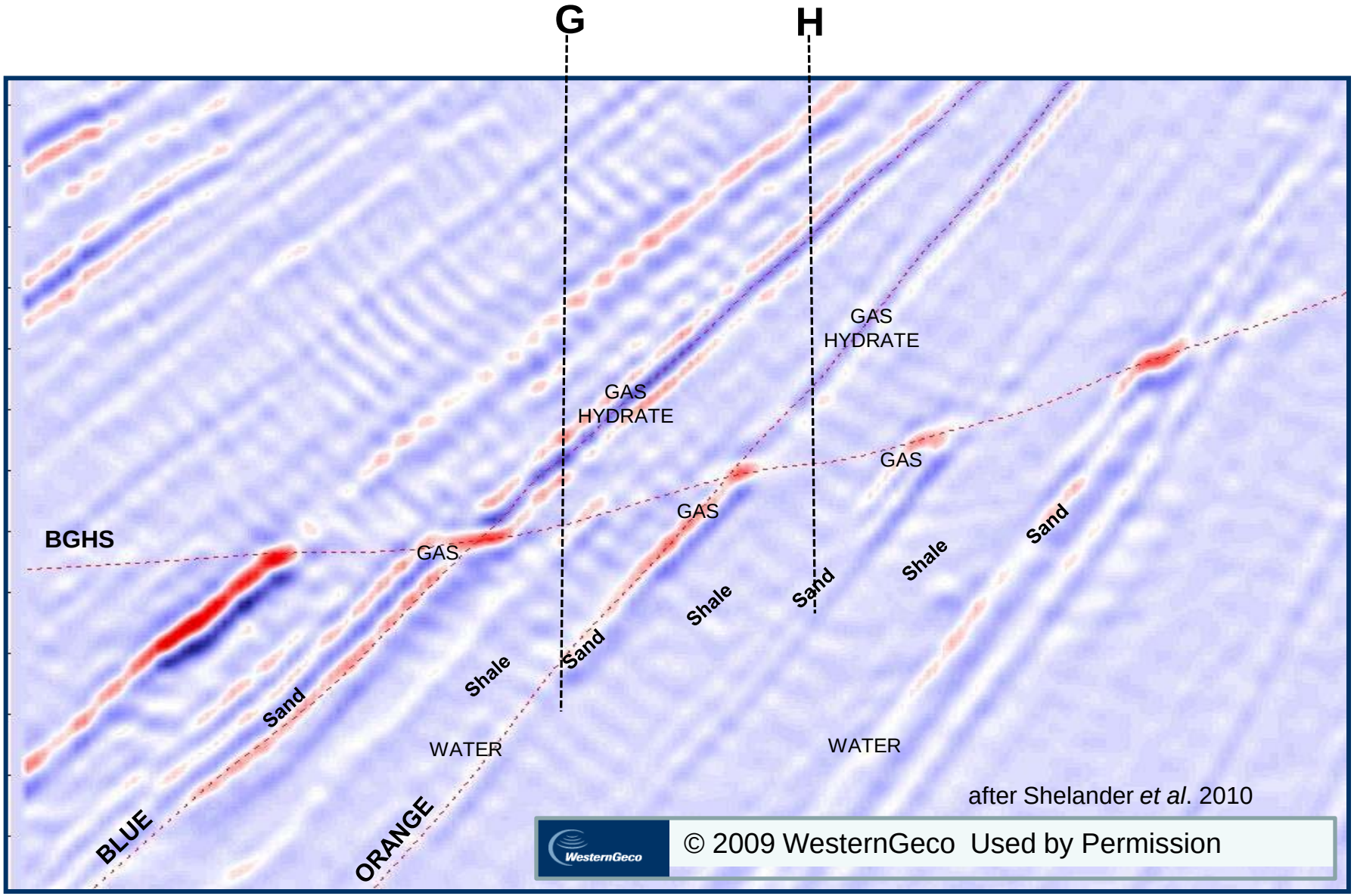
Keathley Canyon

Walker Ridge





Walker Ridge 313 Site Elements



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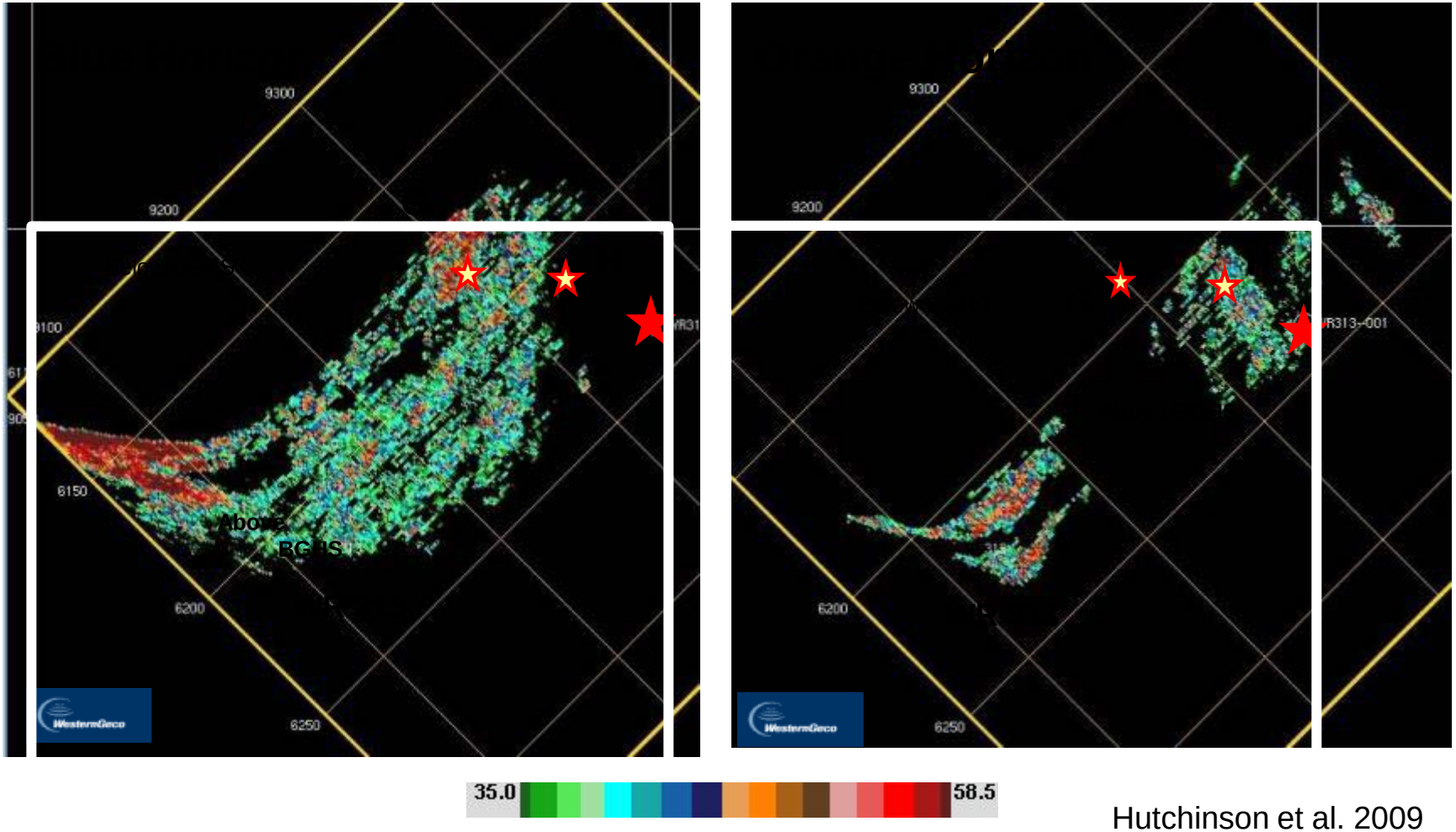
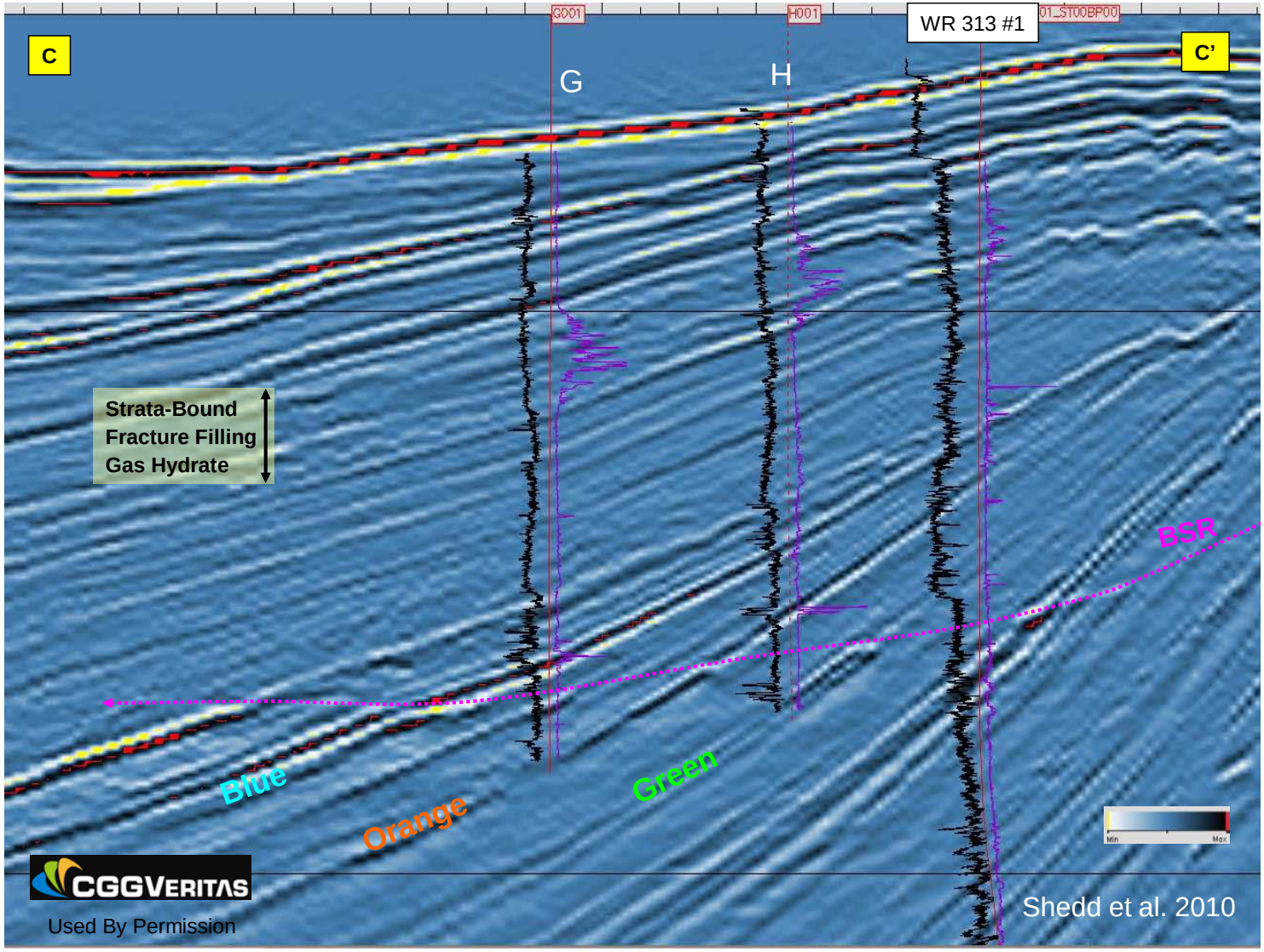
Pre-Drill Seismic Prediction

gas hydrate saturation



Hutchinson et al. 2009

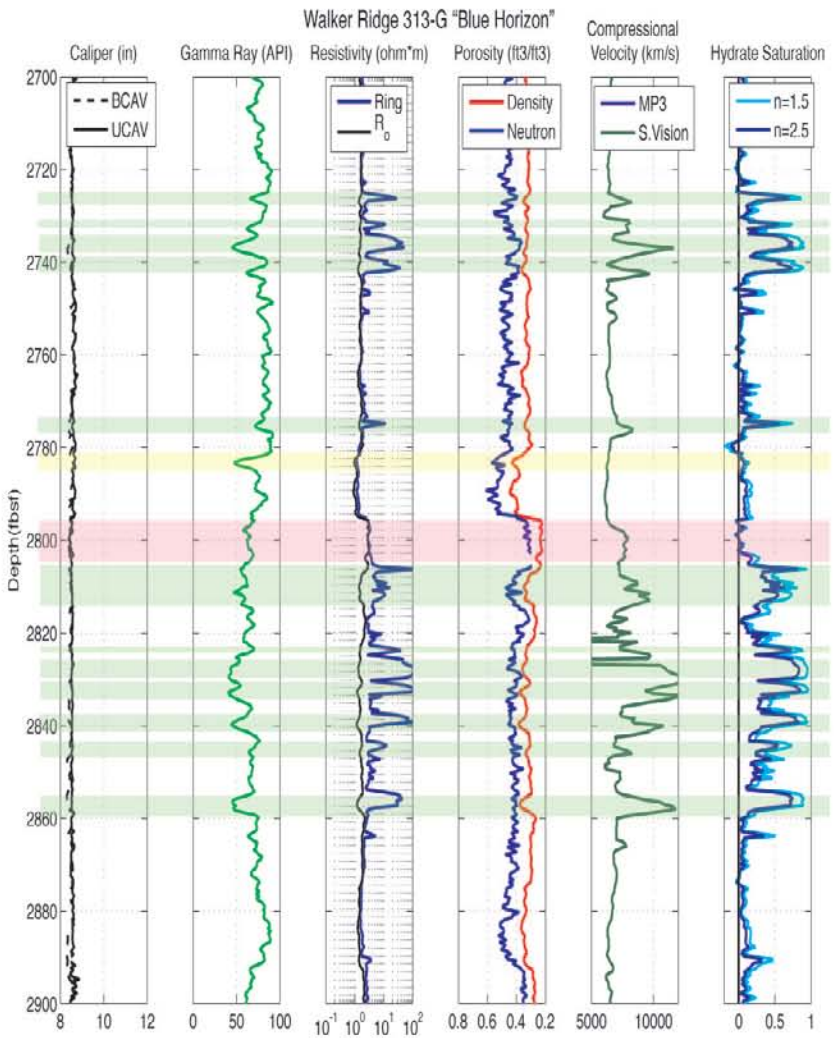
WR 313 LWD Results



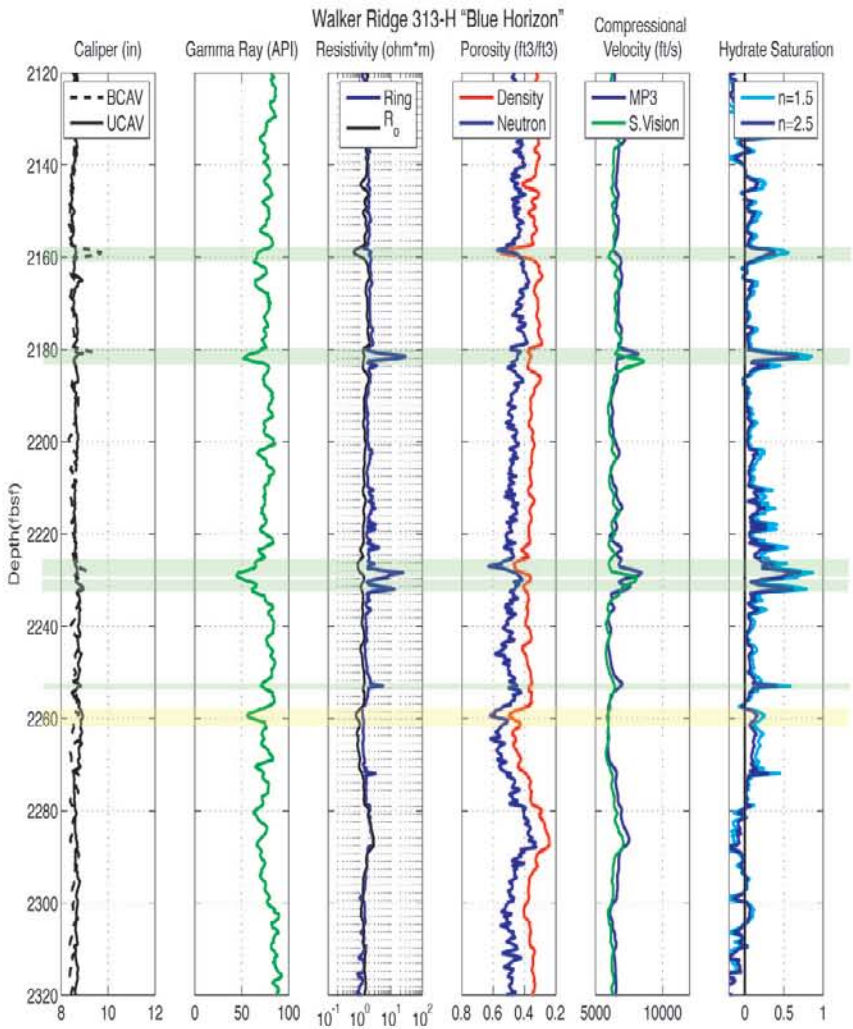
Walker Ridge 313 LWD Results

"blue" unit

DOWN-DIP (G – well)



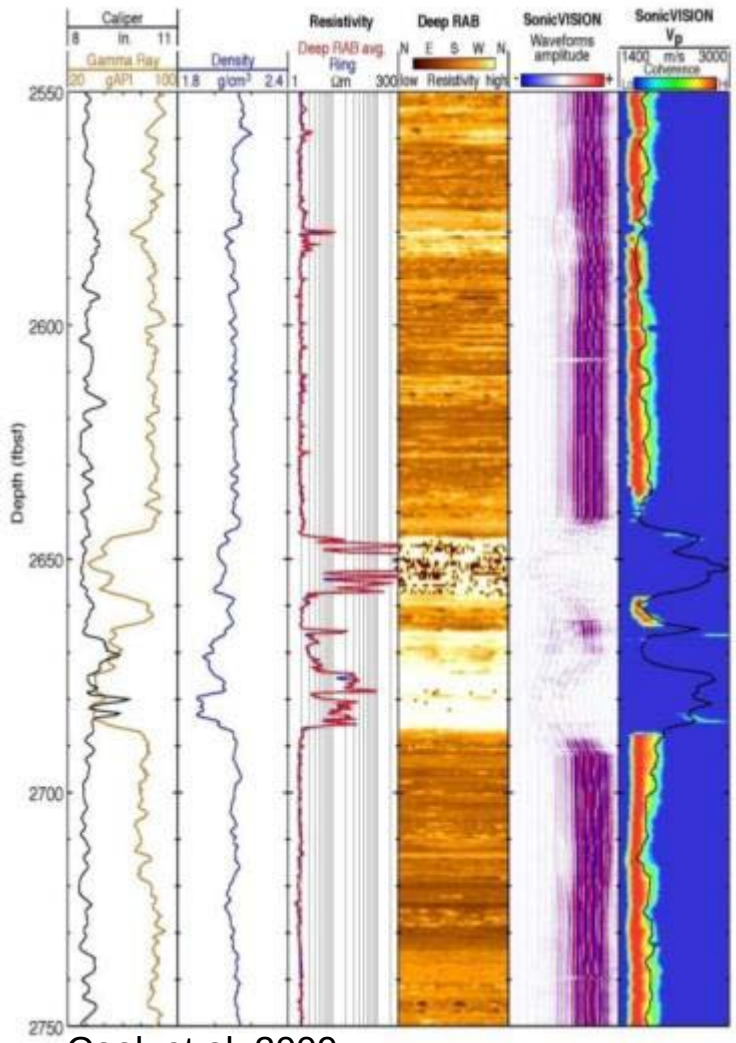
UP-DIP (H – well)



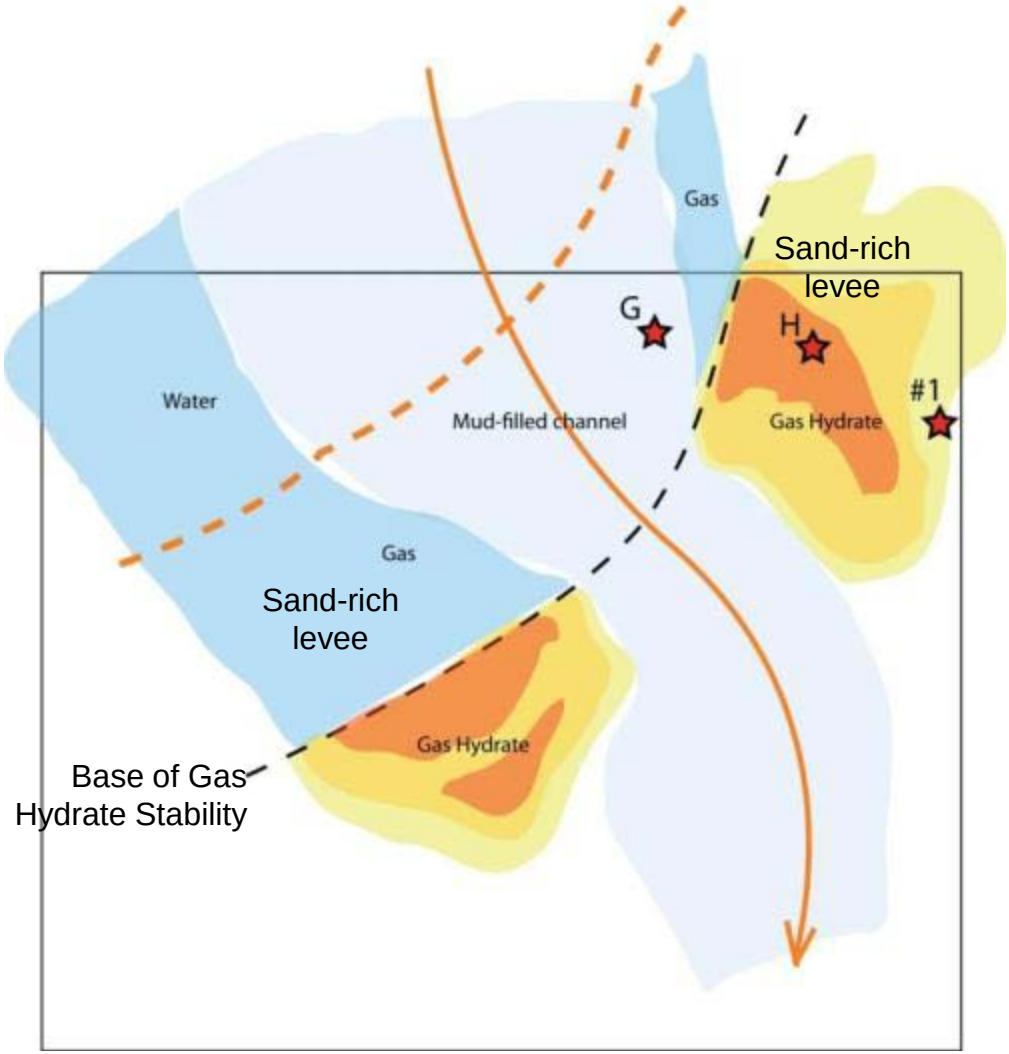
Walker Ridge 313 LWD Results

"orange" unit

WR313-H

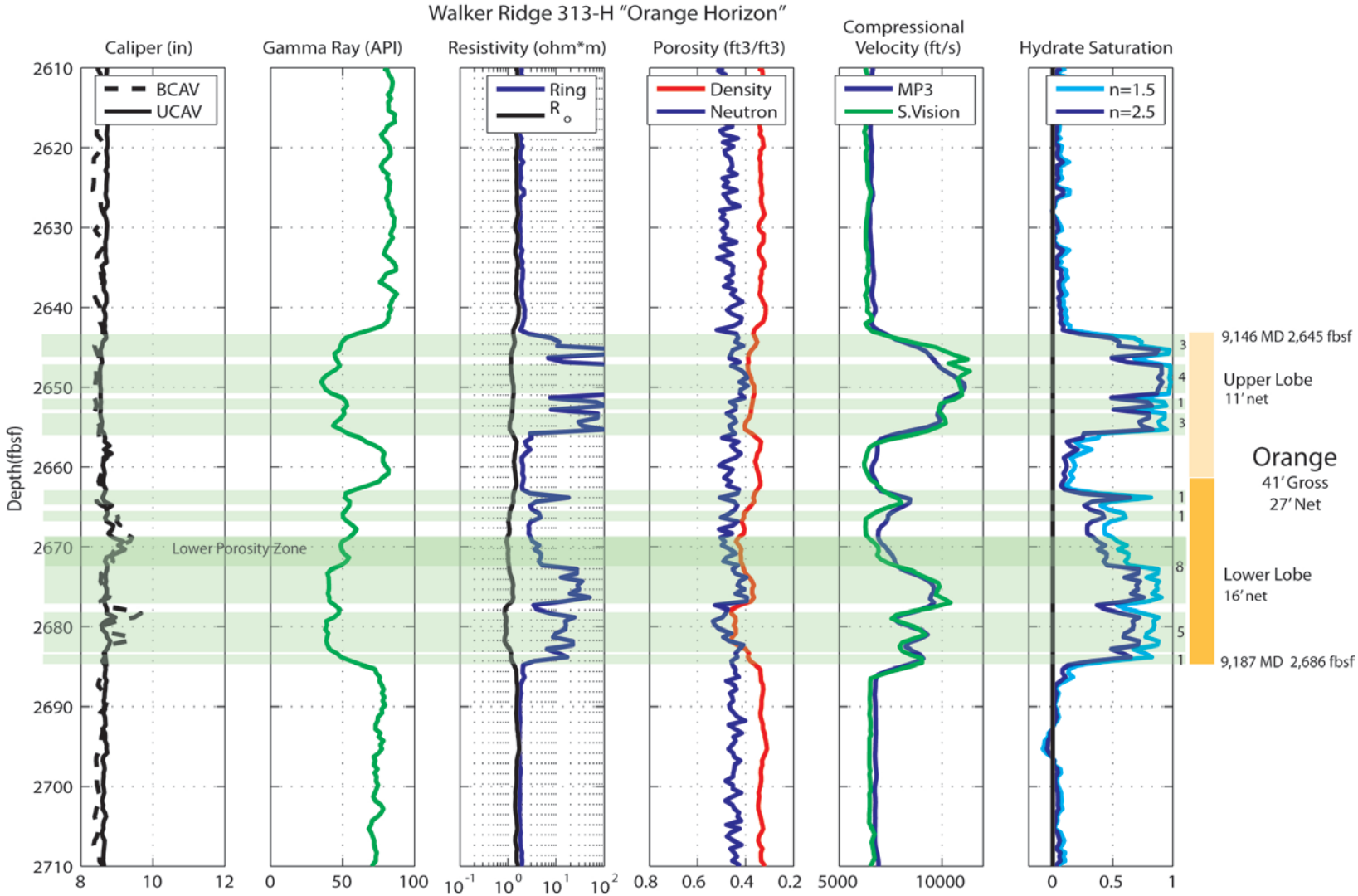


Cook et al. 2009



WR 313 – Orange Sand

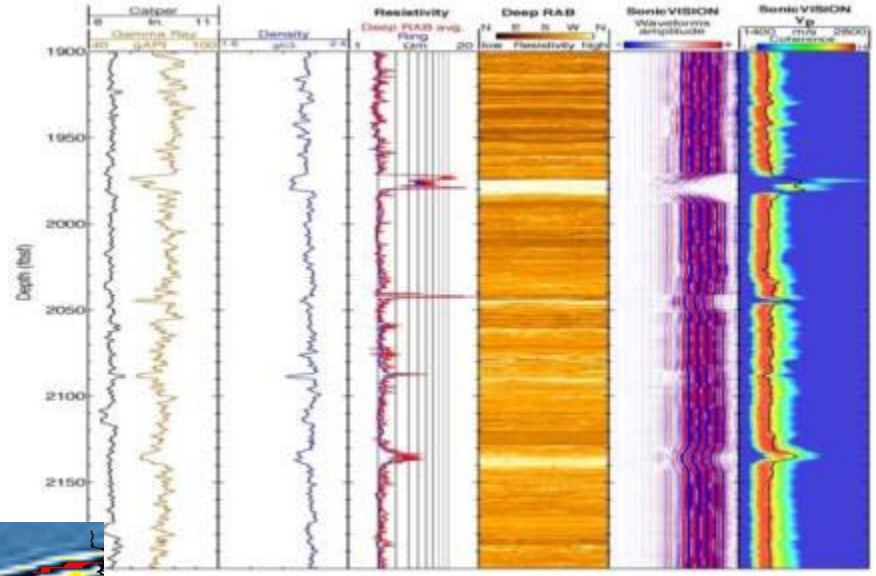
Gas Hydrate Saturation



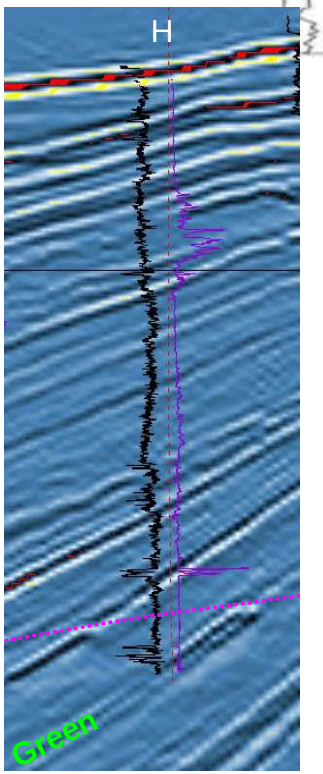
Additional WR 313 GH Occurrences

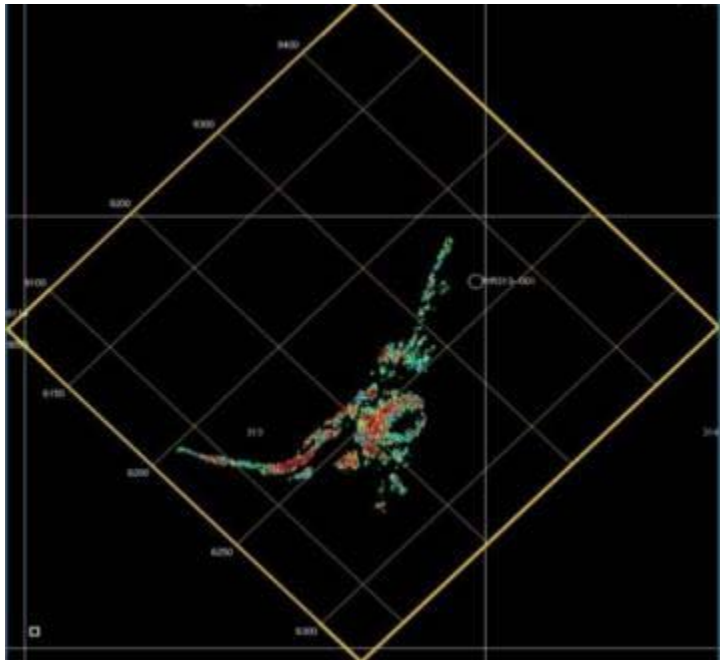
Pore-filling in sands

WR313-G



- 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





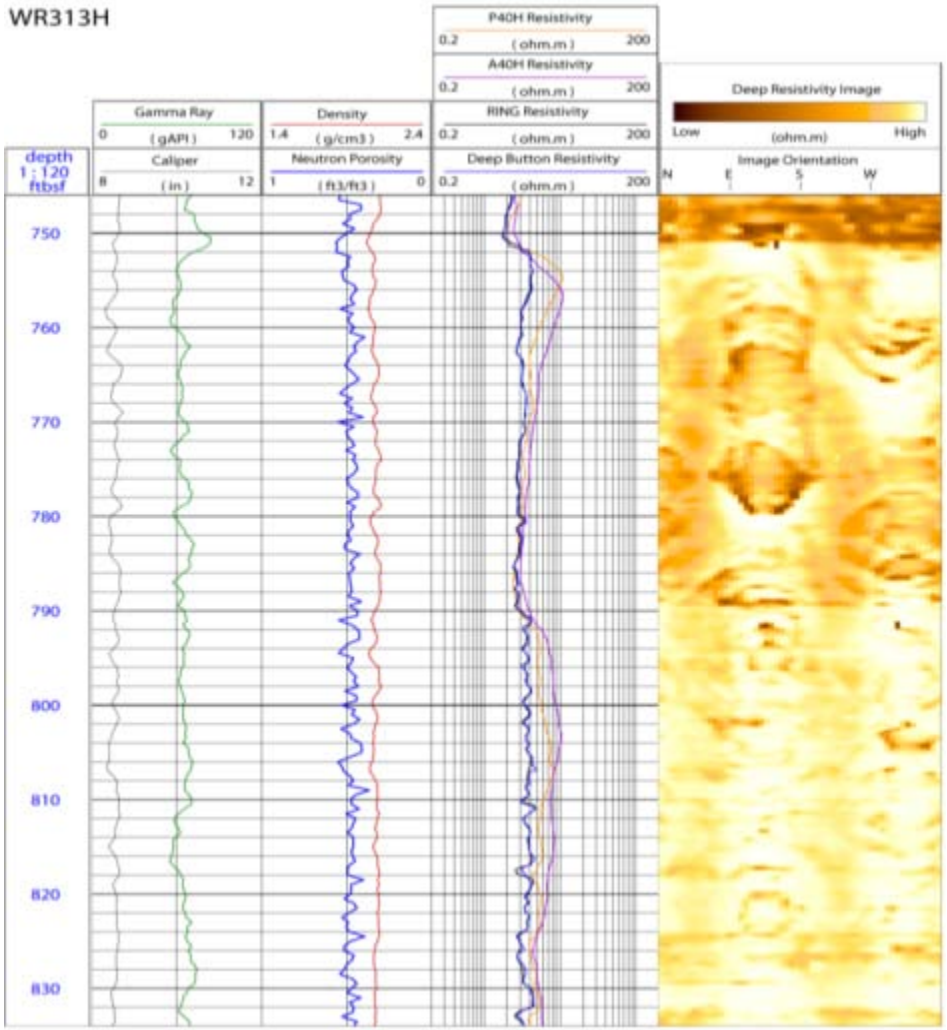
Additional GH Occurrences – WR 313

Fracture-filling in shallow muds

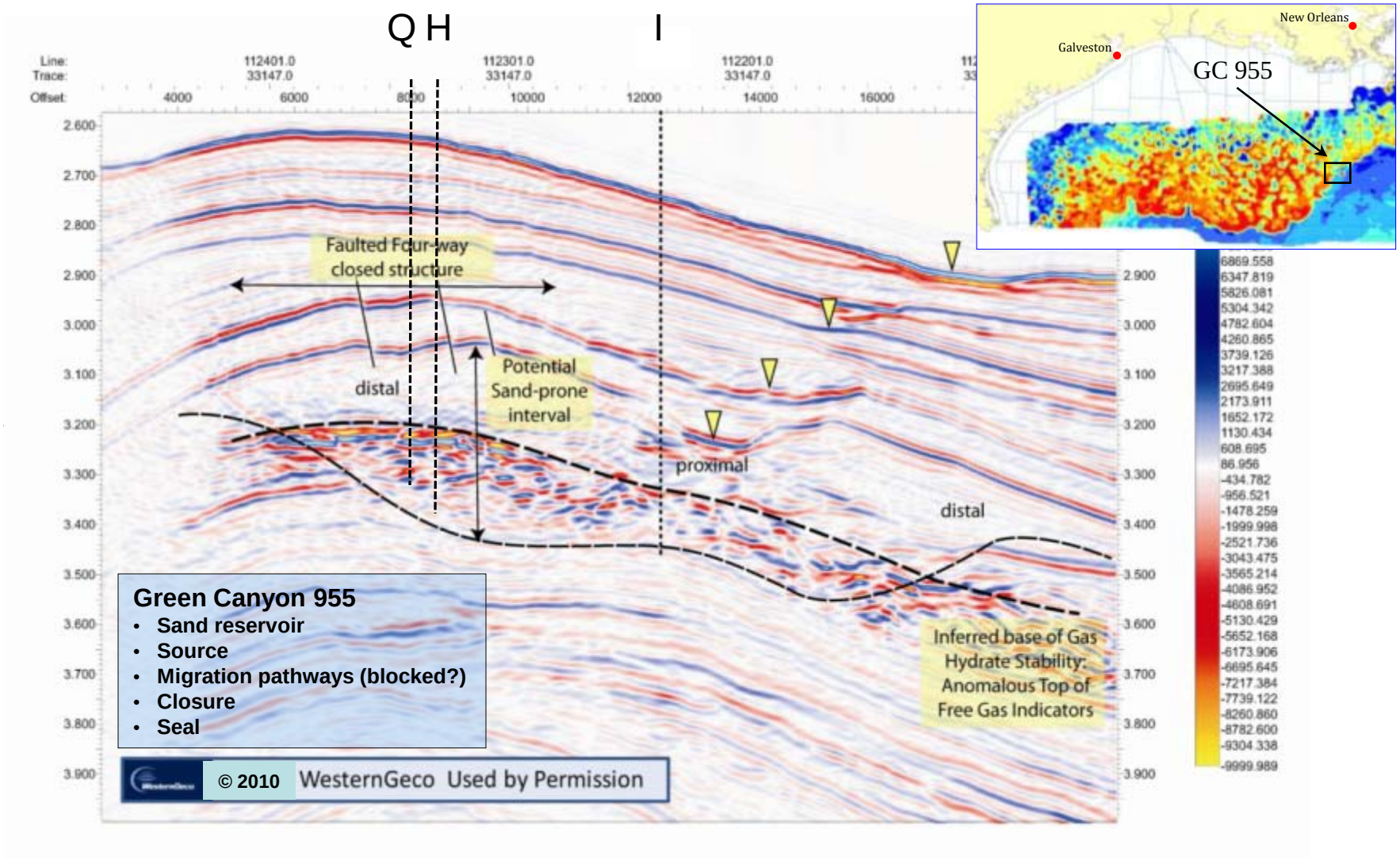
- Occurrence
  - Seen In both JIP wells
  - About 500’ thick
  - Sgh elevated, but uncertain
  - Stratal bound
  - No clear seismic manifestation
  - Origin unclear
- Log Response
  - Fracture forms observable on azimuthal resistivity data
  - Anisotropic resistivity

Cook et al. 2010

WR313-H

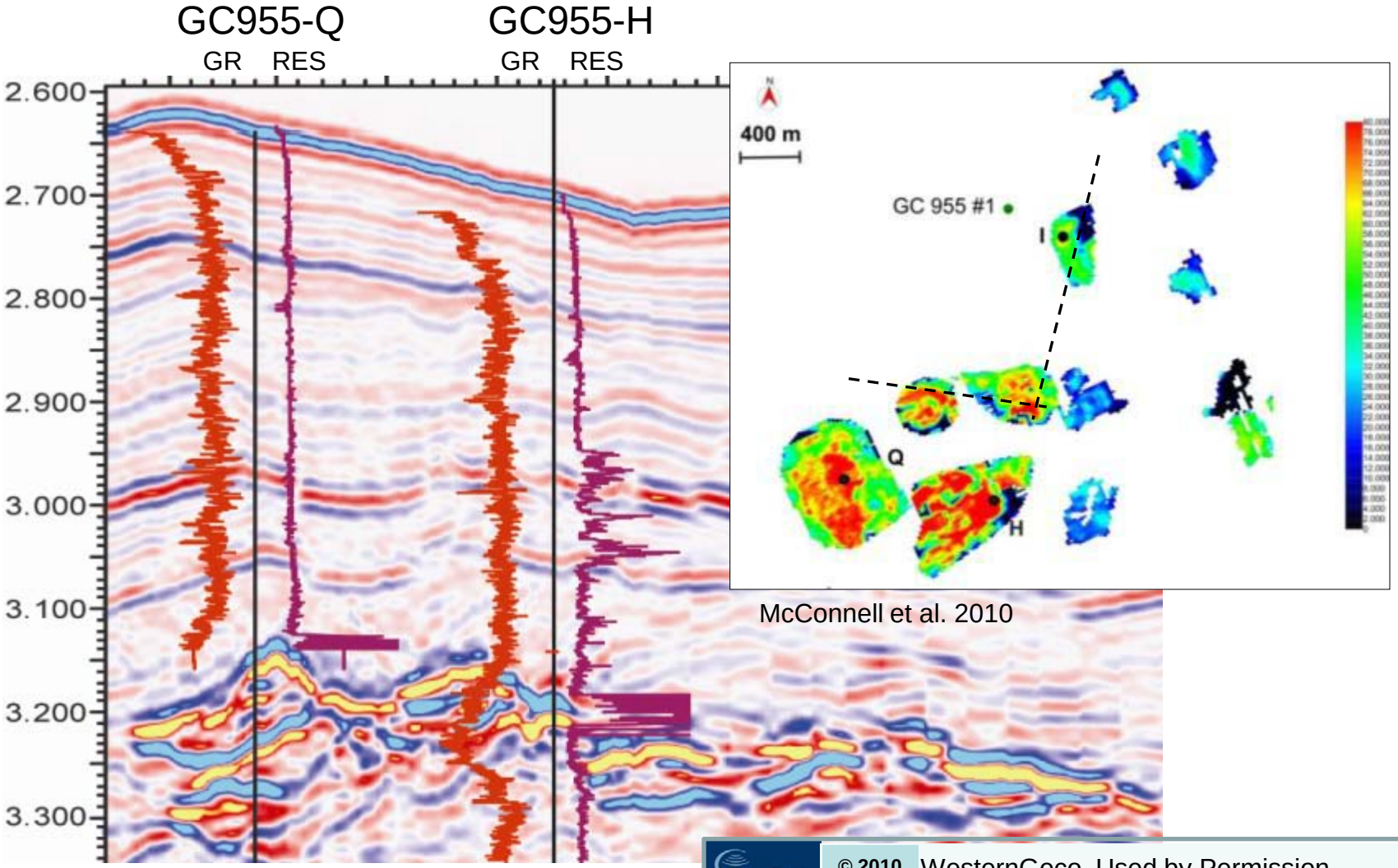


GC 955 Site Elements



GC 955 Targets

Strong "leading peak" amplitudes



McConnell et al. 2010

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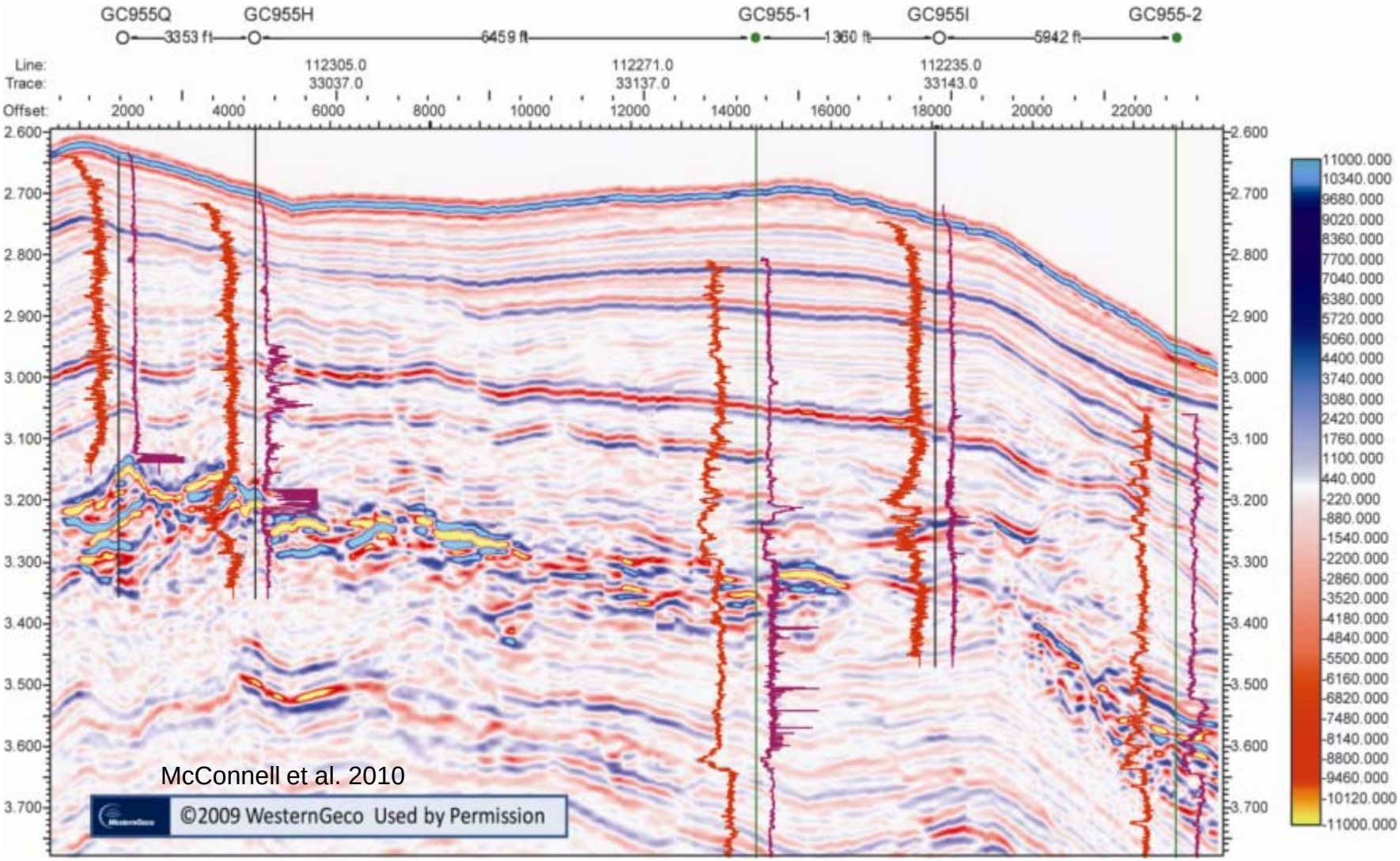
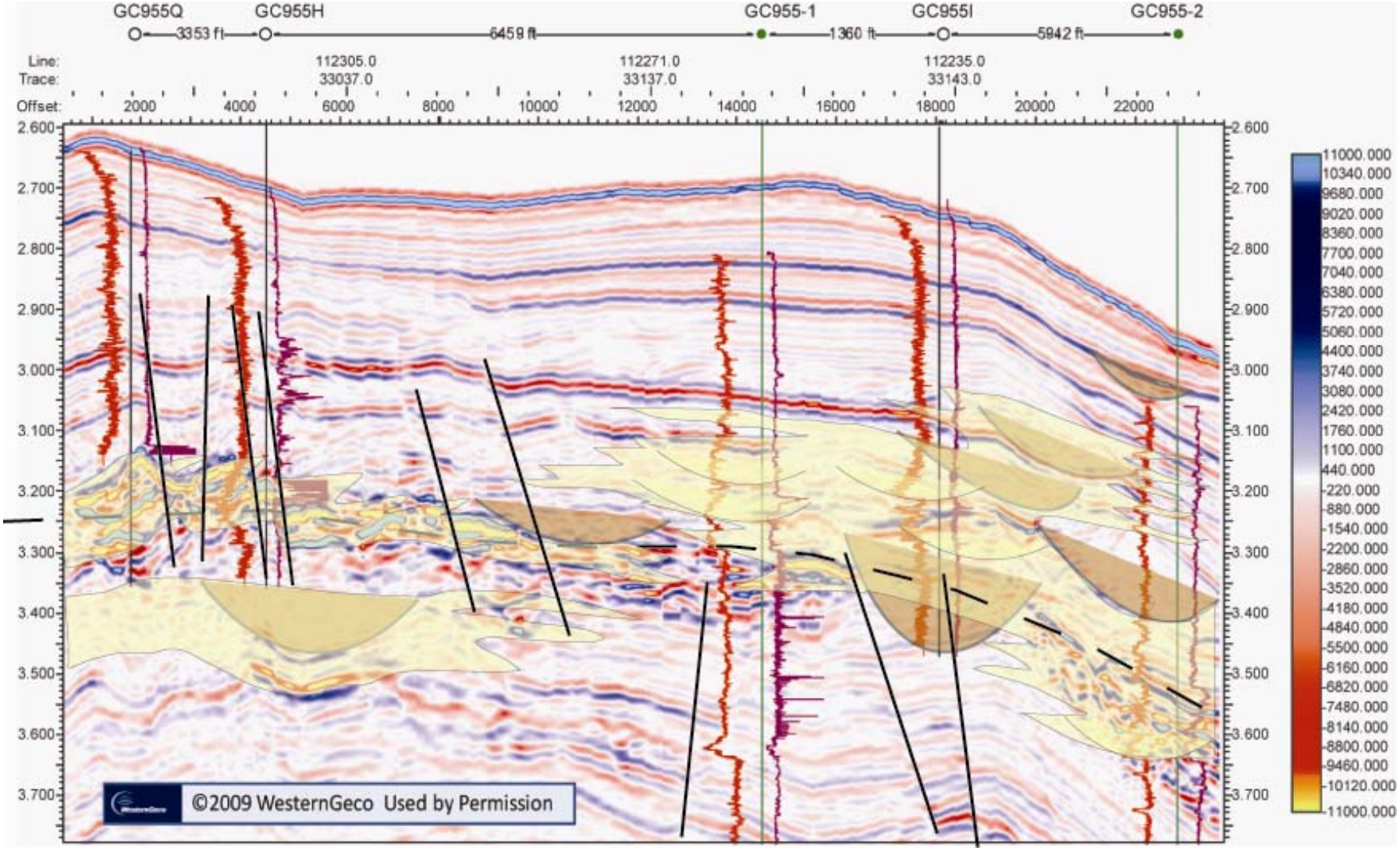
Green Canyon 955-H LWD Results



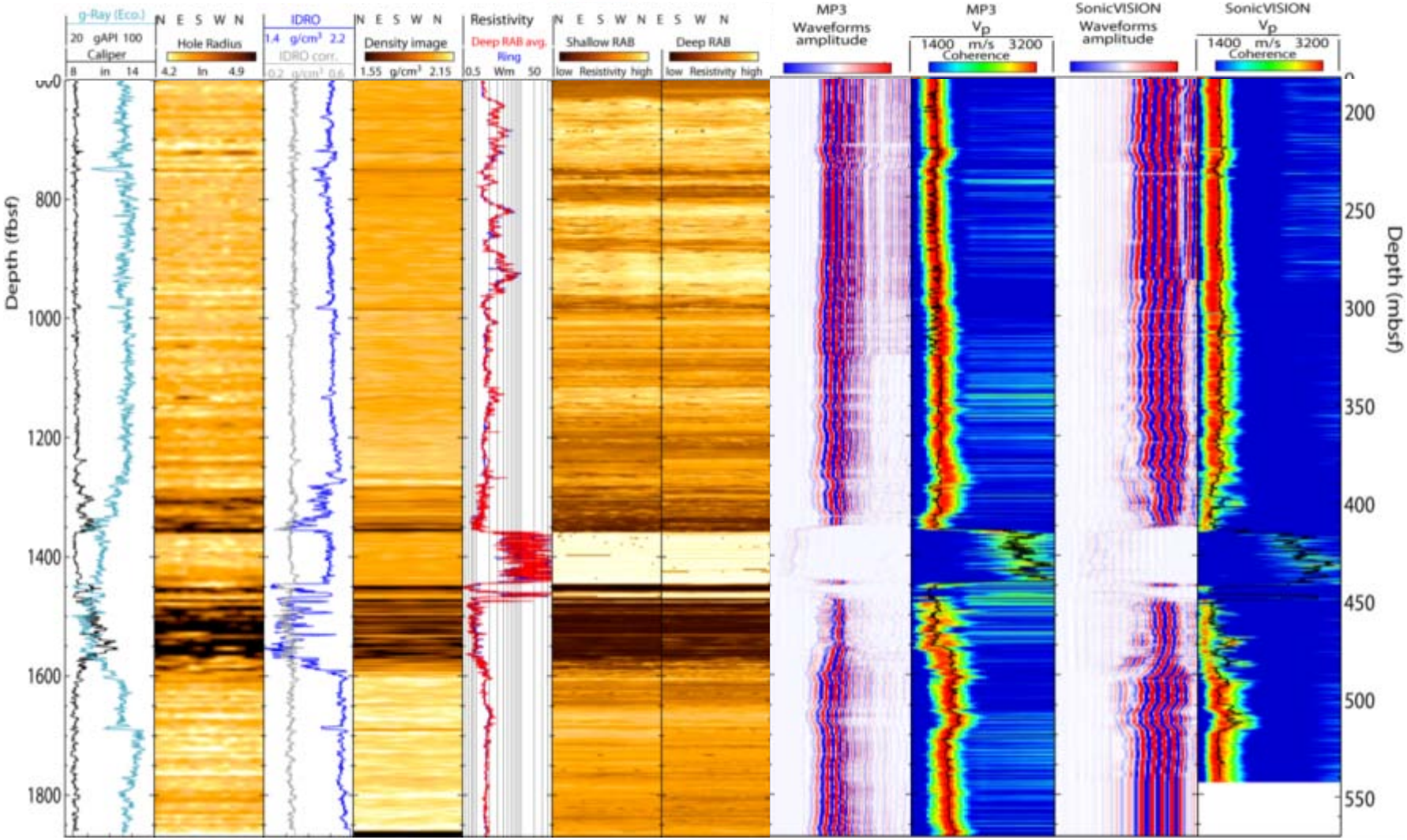
Green Canyon 955-H LWD Results

Complex faulted channel-levee system



Green Canyon 955-H LWD Results

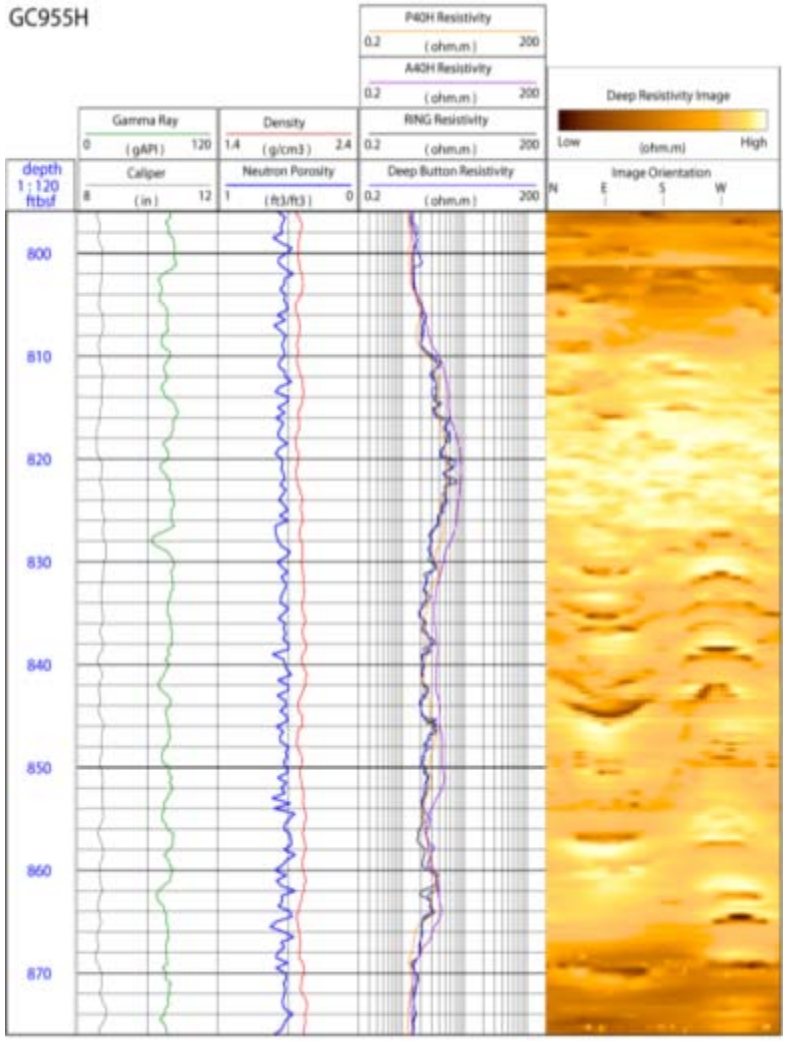
~100’ of GH in sand



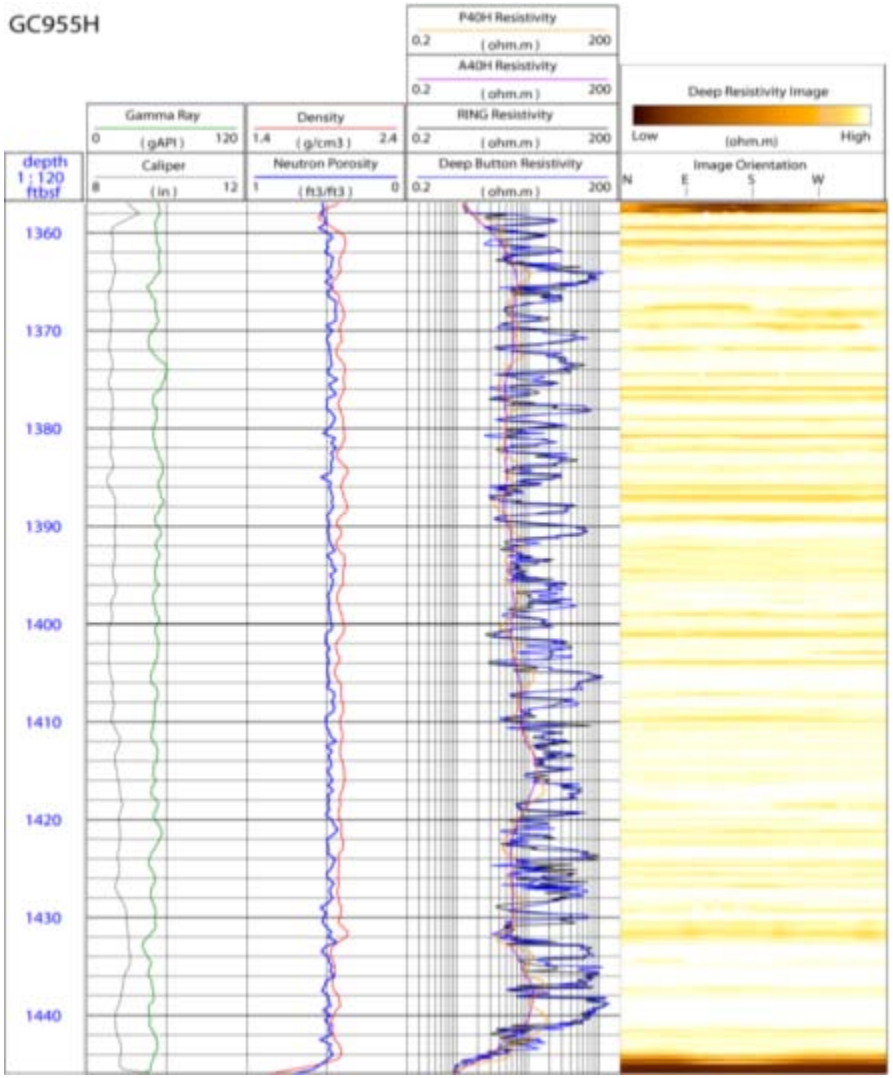
Guerin et al. 2009

Green Canyon 955-H Results

Both fracture/mud and pore-fill/sand modes

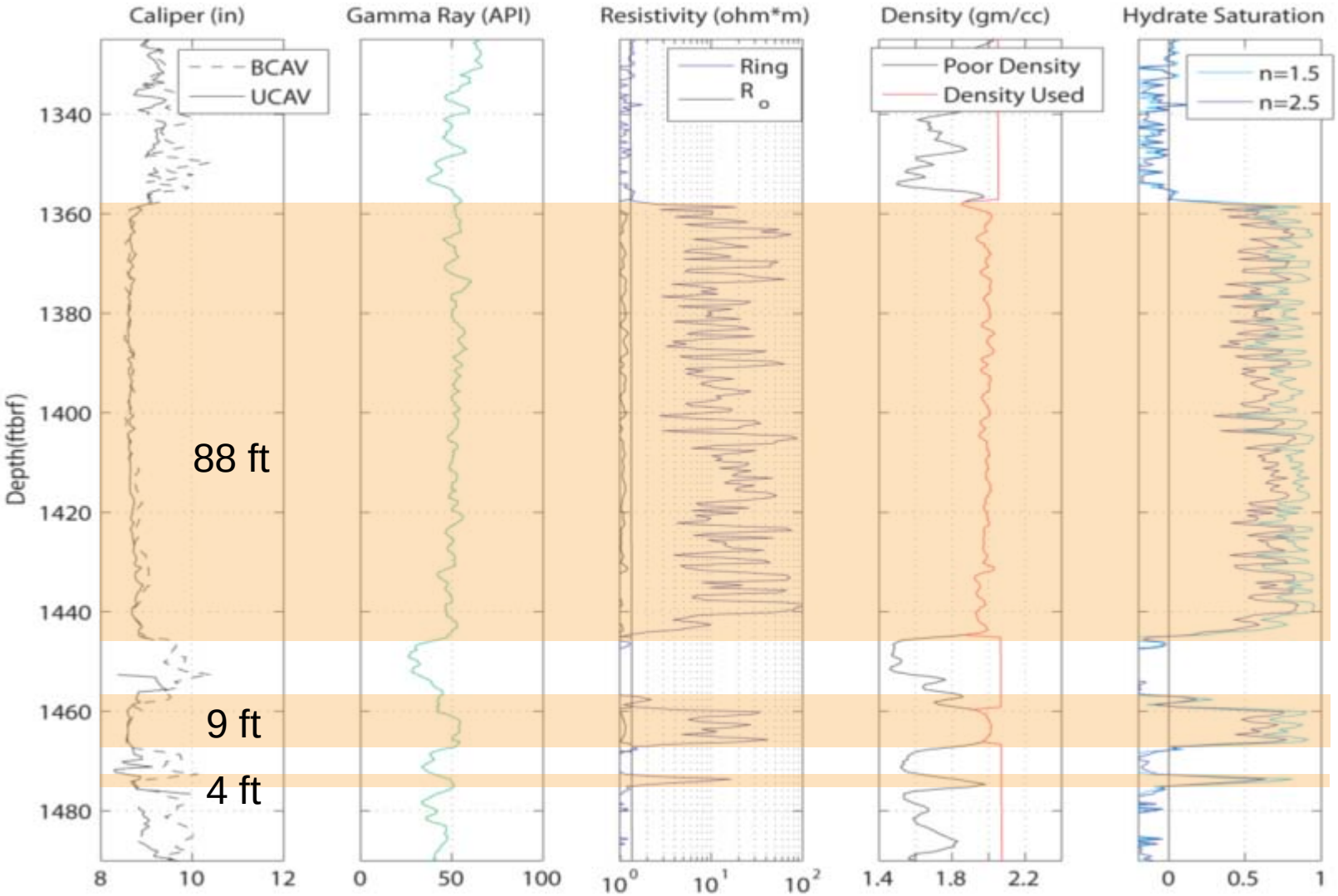


Guerin et al. 2010



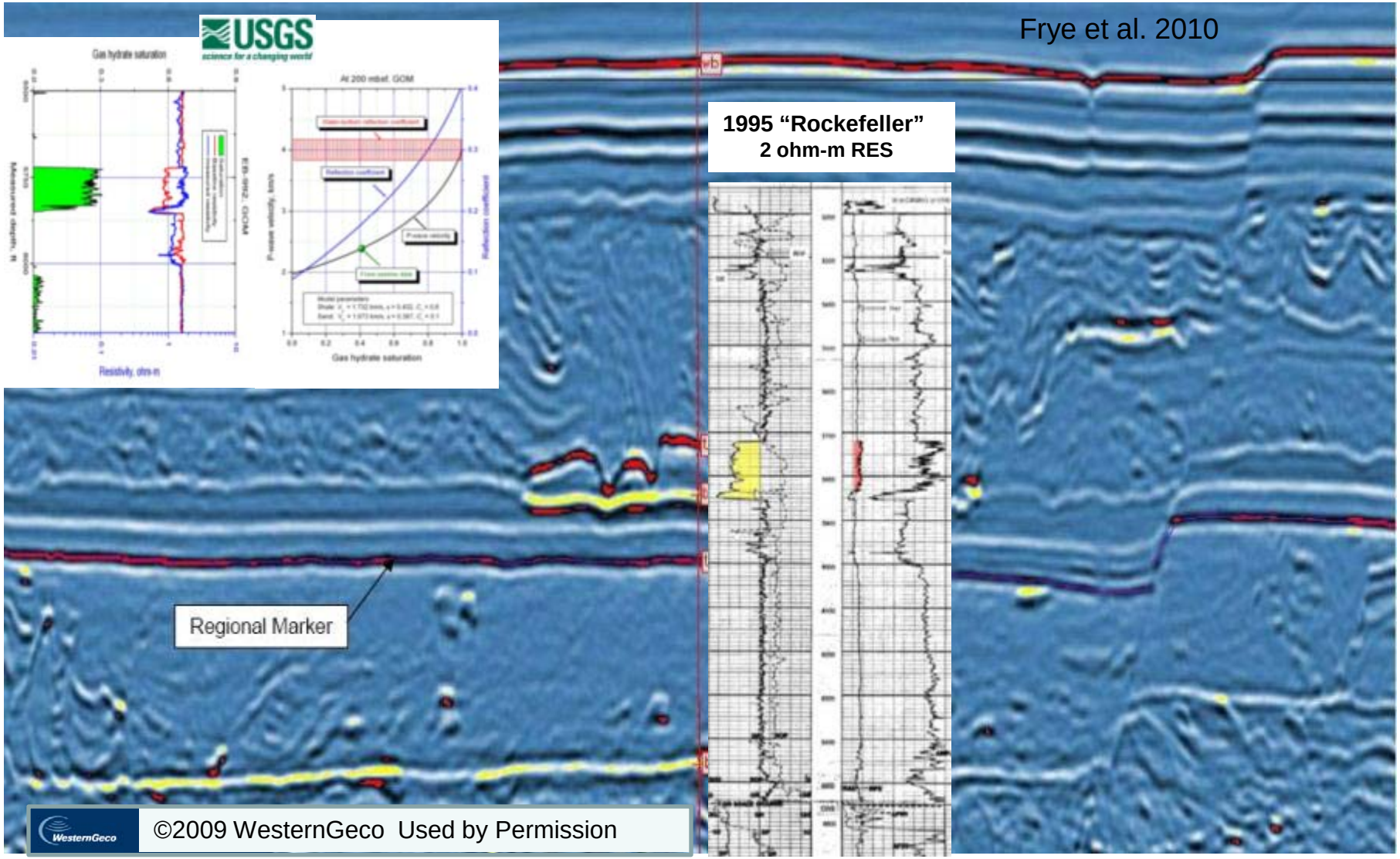
Green Canyon 955-H Results

Complex geologic controls



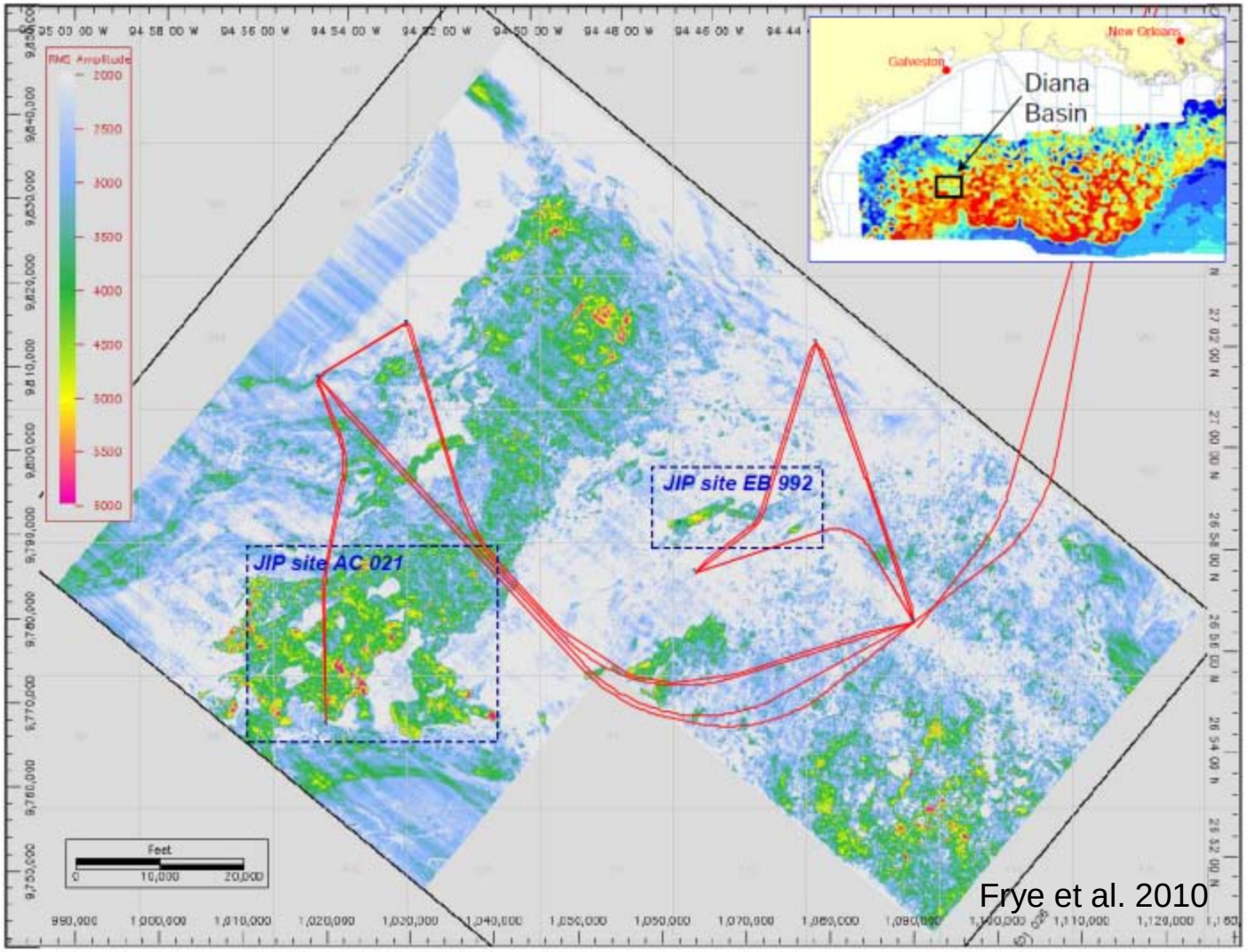
AC 21 Site Elements

Prior evidence of shallow, resistive sand



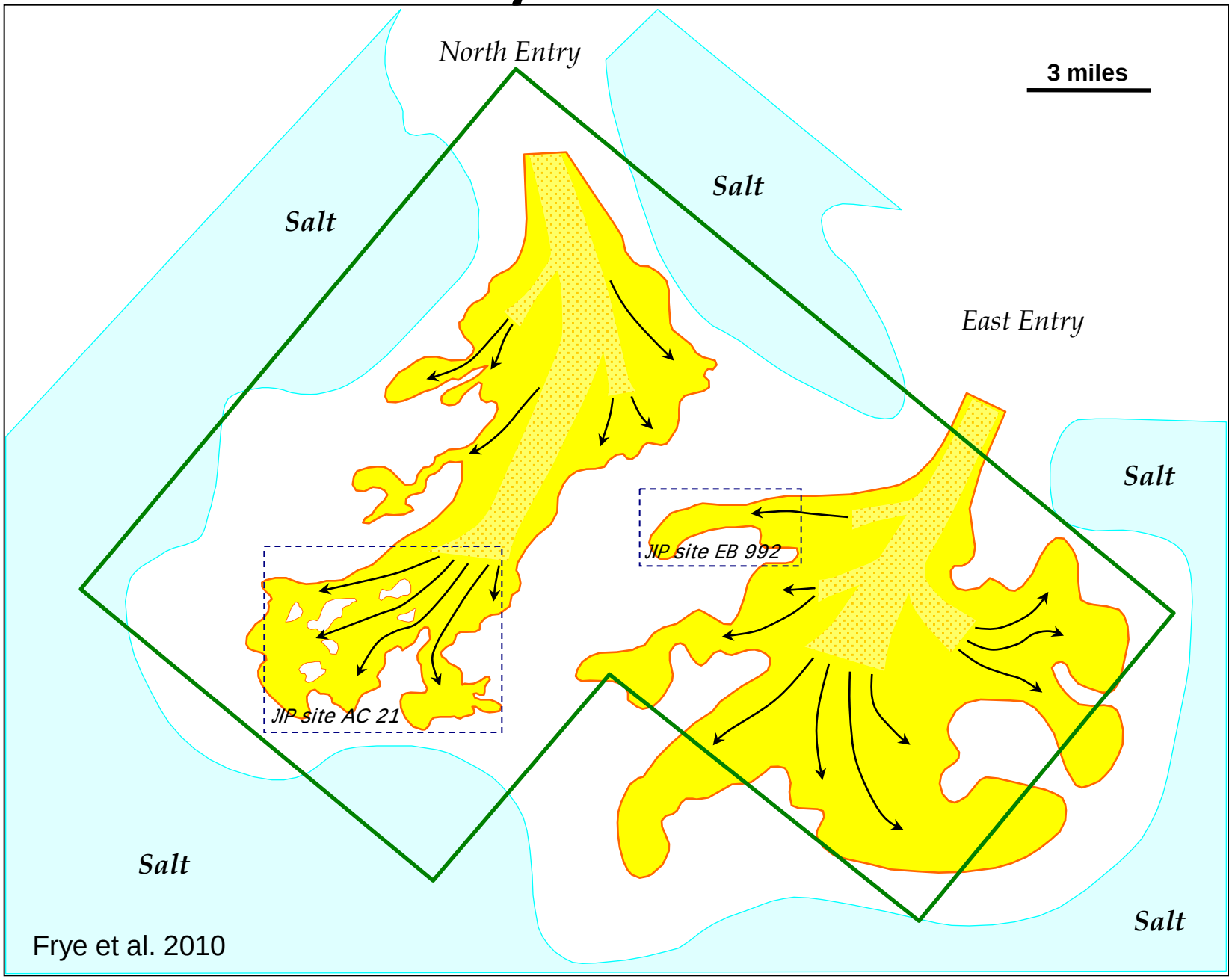
Alaminos Canyon 21

Regional shallow sand target



Frye et al. 2010

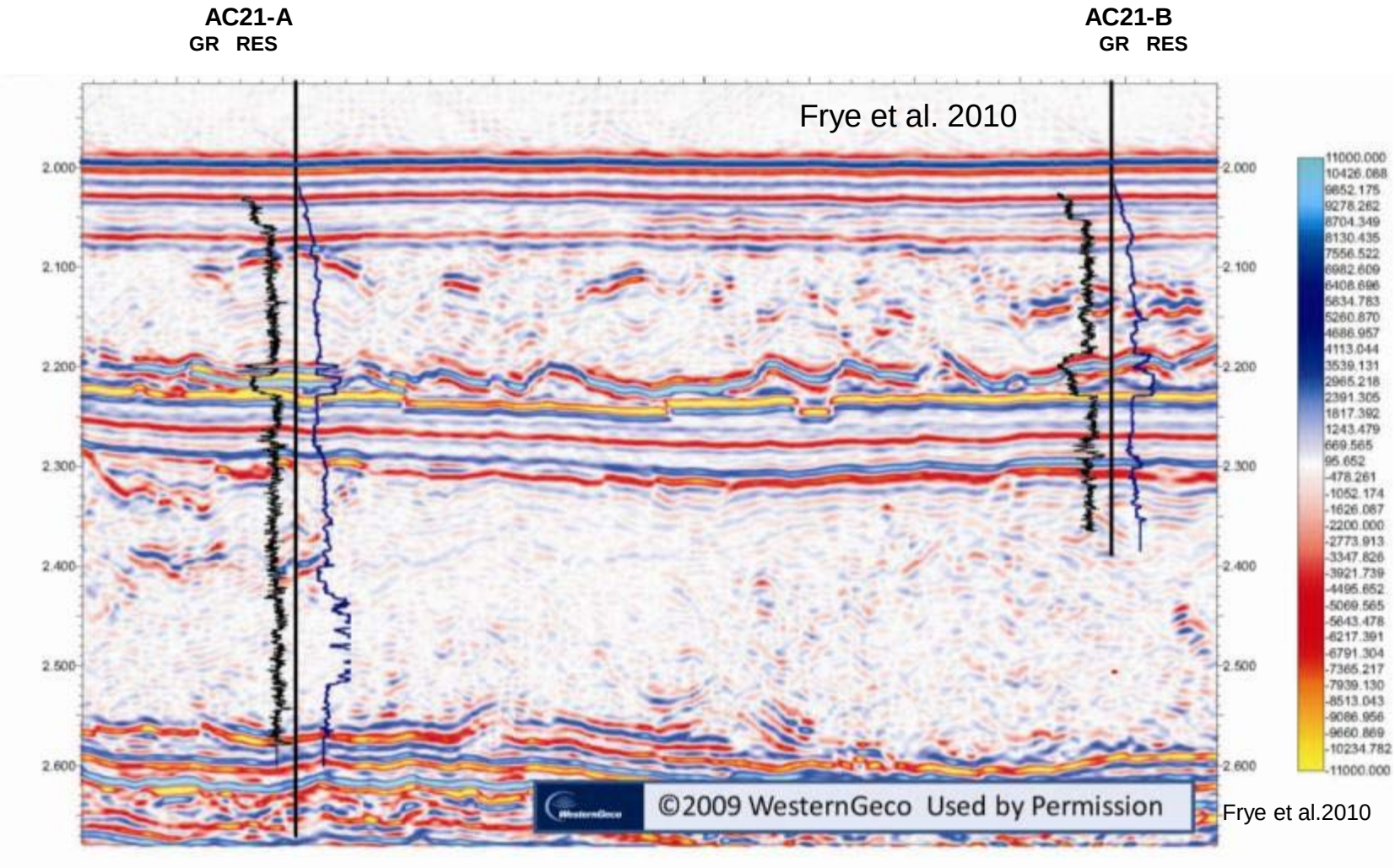
Alaminos Canyon 21 – Sand Model



Frye et al. 2010

Alaminos Canyon 21 Results

consistent 2 ohm-m resistivity

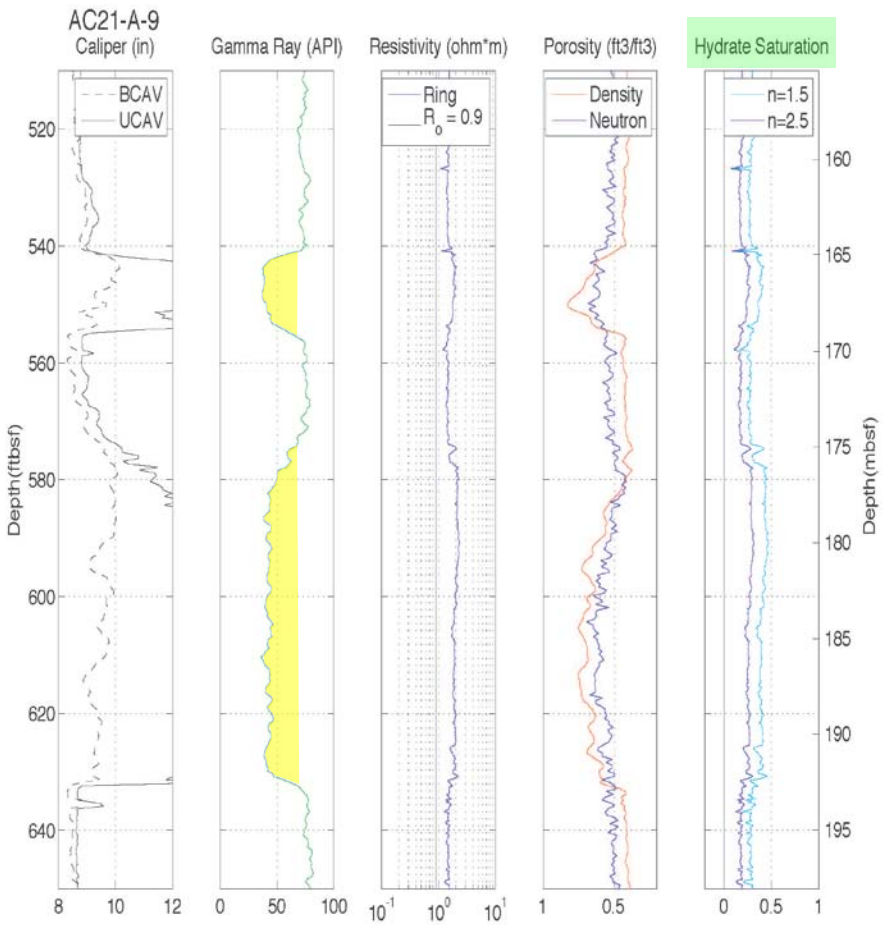


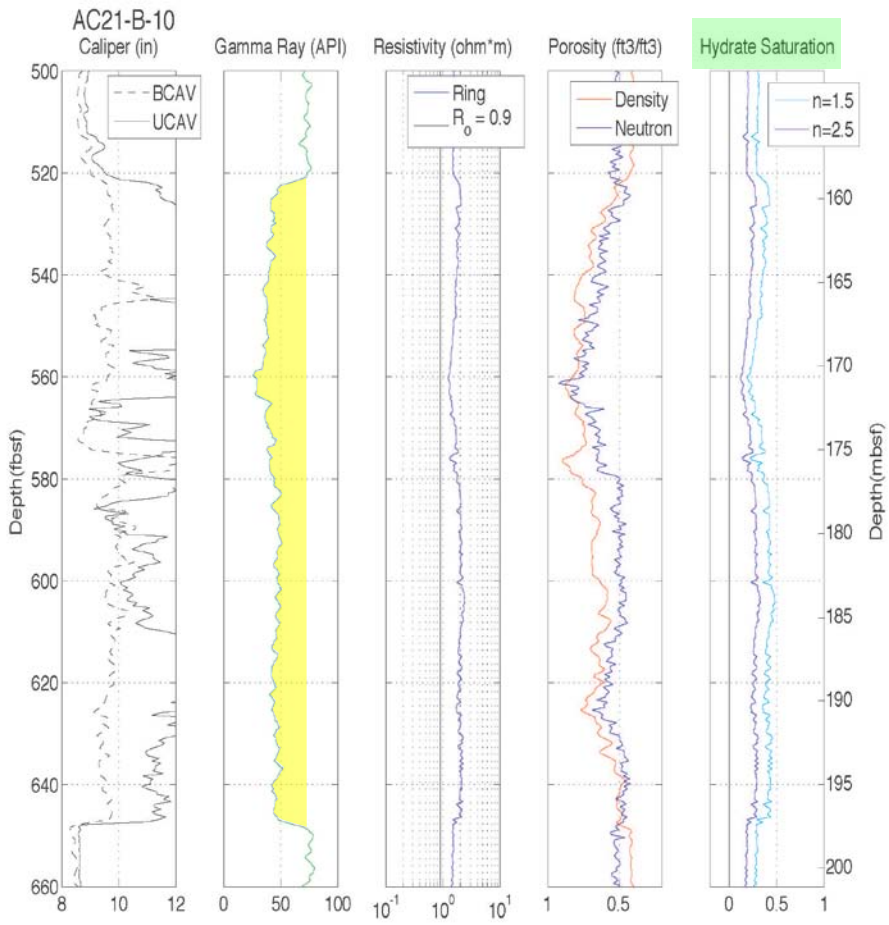
Frye et al.2010

AC 21 LWD Results

low-to-moderate, but uncertain, Sh

Gas Hydrate Saturation potentially 20% to 40%





JIP Leg II – Key Findings

- 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

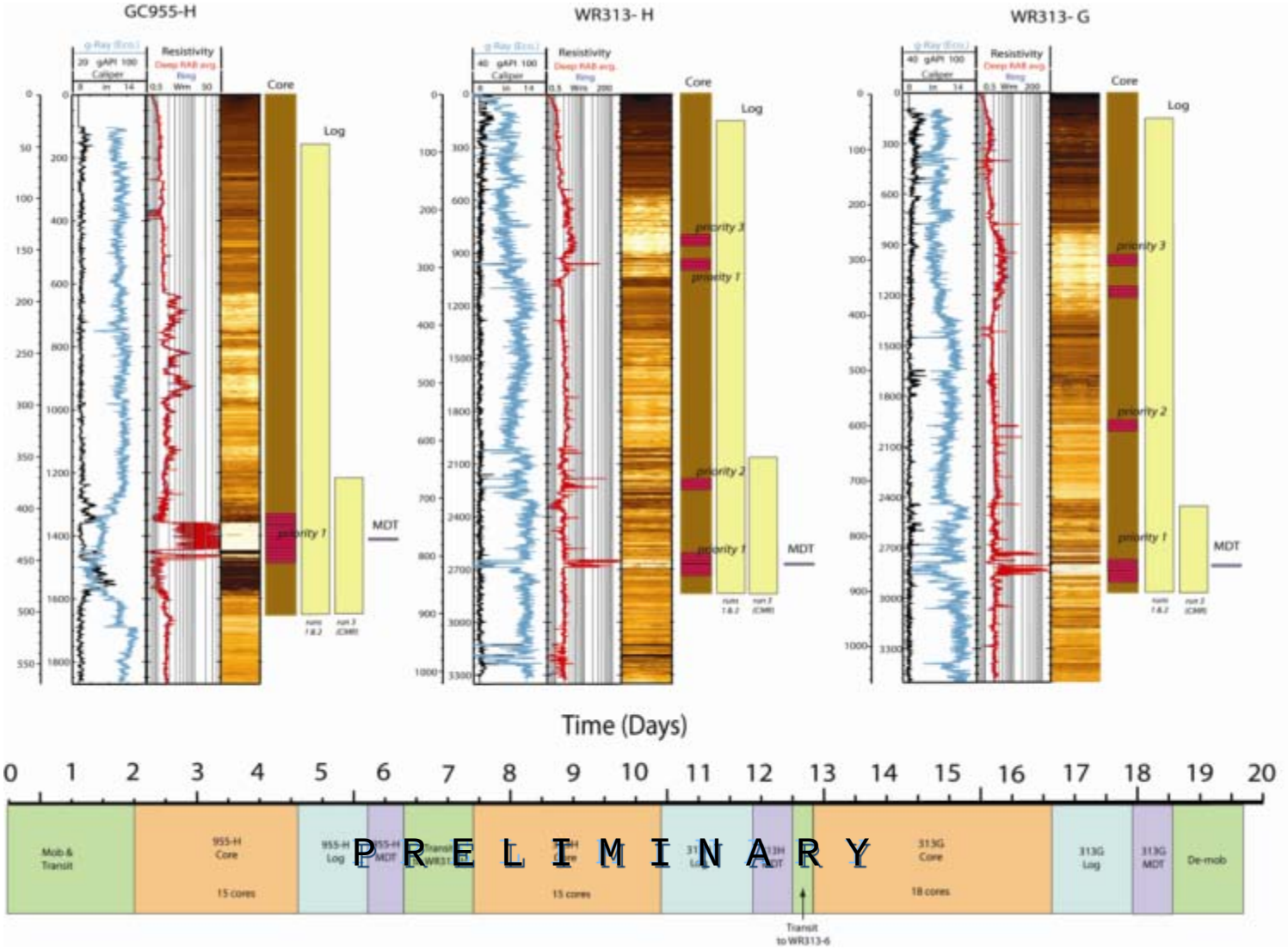
- Gas hydrate R&D
  - 1,000’ deeper than any previous research well
- Full data collection from LWD
- Gas hydrate confirmed in sand reservoirs at multiple sites
  - Excellent research sites for further data acquisition defined
- Confirmation of research approach
  - focus on the reservoir (hydrates in 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/NETL 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



JIP Leg II Reporting

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

Stefan Mrozewski[1], Gilles Guerin[1], Ann Cook[1], Timothy Collett[2], & Ray Boswell[3]

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 logging-wh
drilling (MV
Measurem

LWD tools
hole assem
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often used
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The LWD tools used during JIP Leg II were the MP3 (multipole acoustic - recently commercialized under the name SonicScope), geoVISION (electrical imaging), EcoScope (propagation resistivity, density and neutron),

Gulf of Mexico Gas Hydrate Joint Industry Project Leg II: Alaminos Canyon 21 Site Summary

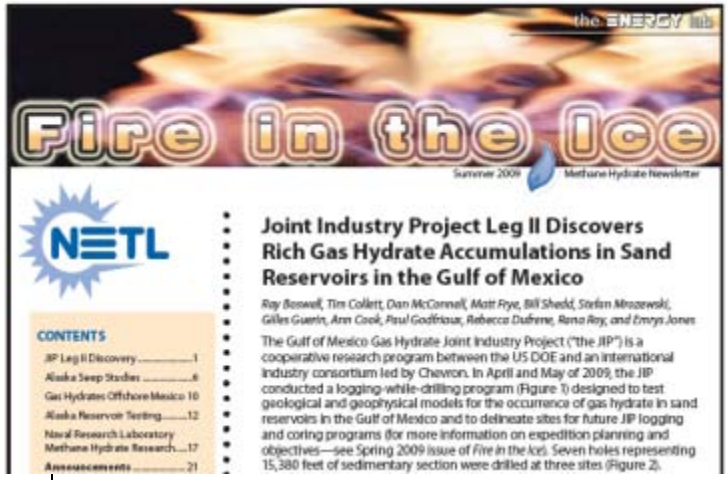
Matthew Frye[1], William Shedd[2], Paul Godfriaux[2], Timothy Collett[3], Myung Lee[3], Ray Boswell[4], Rebecca Dufrene[4], & Dan McConnell[5]

Abstract

The primary goal of the Gulf of Mexico (GOM) Joint Industry Project (JIP) Leg II drilling program was to locate and record the occurrence of gas hydrate in high-quality deepwater sand reservoirs. In the first week of May, 2009, the JIP utilized the Helix Q-4000 semi-submersible to drill and log two wells in the Diana sub-basin in the northwestern GOM at the Alaminos Canyon (AC) 21 Site. The AC 21-A and AC 21-B wells confirmed the presence of an areally extensive, sand-rich deepwater fan system that was predicted from industry 3-D seismic data and existing industry well penetrations. The primary targets were encountered within 600 ft of the seafloor, well above the predicted base of gas hydrate stability depth of approximately 1,500 feet below sea floor (fbsf). The target sand reservoirs as seen in the A and B wells measured 62 ft and 125 ft, respectively, and contained elevated formation resistivity consistent with low to moderate saturations of gas hydrate (20% to

geological and geophysical analyses conducted with the intent of locating gas hydrate-bearing sand reservoirs (see Hutchinson *et al.*, 2009a, 2009b; Shedd *et al.*, 2009b) and conducting comprehensive logging while drilling (LWD) operations (see Collett *et al.*, 2009b) in advance of planned Leg III coring and pressure coring. This report presents the geologic setting and initial scientific results of LWD operations conducted at the Alaminos Canyon block 21 site (Site AC21). Detailed descriptions of the LWD operations and data acquisition for this site are provided in Mrozewski *et al.* (2009) and Guerin *et al.* (2009).

The AC 21 site lies within the northwestern GOM along the boundary between the Alaminos Canyon and East Breaks (EB) protraction areas (Figure F2). It is one of two drill sites evaluated by the JIP for possible Leg II operations within the Diana intra-slope basin (Shedd *et al.*, 2009b). Three well locations were permitted at Site AC 21 to test gas



OTC 20560

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

Ray Boswell, U.S. Department of Energy; Timothy S. Collett, U.S. Geological Survey; Dan McConnell, AOA Geophysics; Matthew Frye and William Shedd, Minerals Management Service, Stefan Mrozewski, Gilles Guerin, and Ann Cook; Columbia University; Dianna Shelander and Jianchun Dai, Schlumberger; Paul Godfriaux and Rebecca Dufrene, Minerals Management Service, Emrys Jones and Rana Roy, Chevron

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Abstract

The Gulf of Mexico gas hydrates Joint Industry Project (the JIP) is a cooperative research program between the US Department of Energy, collaborating federal agencies including the U.S. Geological Survey and Minerals Management Service, and an international industrial consortium under the leadership of Chevron. The JIP conducted its "Leg II" logging-while-drilling (LWD) operations at three deepwater sites in the Gulf of Mexico in April and May of 2009. Leg II was intended to expand upon previous JIP work that had focused primarily on geohazards related to drilling through fine-grained gas hydrate bearing systems by investigating the occurrence and nature of pore-filling gas hydrate in sand reservoirs in the Gulf of Mexico. The locations for JIP Leg II drilling were the result of an integrated geological and geophysical prospecting approach that considered direct geophysical evidence for gas hydrate-bearing strata in the context of evaluation of indicators for gas sourcing, gas migration pathways to the shallow section, and occurrence of sand reservoirs within the gas hydrate stability zone. The expedition experienced minimal operational issues with the advanced LWD tool string, and successfully managed a number of non-gas-hydrate-related shallow drilling hazards. Two wells drilled in Walker Ridge block 313

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.)

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