The Lower Tertiary Wilcox Trend in the Deepwater Gulf of Mexico*

By

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Abstract

Initial Lower Tertiary penetrations in the western deepwater Gulf of Mexico documented a 6,000'+ succession of Wilcox (upper Paleocene – lower Eocene) turbidites located 250 miles down-dip from their fluvial and deltaic equivalents. These same thick turbidites have also been discovered 200 - 300 miles to the east, in new exploration wells in this emerging trend. Regional synthesis demonstrates a systematic progression from lower slope to extensive fan sands, to starved distal basin.

The deepwater Wilcox Trend covers 30,000+ square miles. Well target depths range from 12,000' – 35,000' subsea, water depths range from 4,000' – 10,000', salt canopies vary from 7,000' - >20,000' thick, and cover approximately 90% of the trend. Twenty+ wildcats have been drilled in the Wilcox Trend, with 12 announced discoveries, ranging from 40 – 500 MMboe recoverable reserves. Ultimately, the Wilcox trend has the potential for recovering 3 – 15 bboe reserves from these and additional untested Louann salt-cored structures.

The Jack #2 production test (Walker Ridge 758) had a sustained flow rate over 6,000 bopd from approximately 40% of the reservoir. The test occurred in 7,000' of water and greater than 25,000' subsea, and established six world production test records. Test results significantly increase understanding of trend deliverability.

Many technical challenges need to be resolved to move the billions of barrels of resource trapped in deepwater Wilcox structures to recoverable economic reserves. These challenges include complex sub-salt imaging improvements, reservoir quality, sand distribution, and flow capability, and cost effective drilling and completion, facility, and infrastructure designs.
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Agenda

1) Drill History
2) Trend Characteristics
3) Jack Well Test
4) Trend Challenges
Lower Tertiary: Drill History

Mexico Waters

Chinook

2D Time

Wilcox

Thanks to TGS – NOPEC

(2D Time Migration)
Lower Tertiary: Drill History

- Walker Ridge
- Green Canyon
- Salt Province
- Texas
- Louisiana
- Continental Shelf
- Mexican Waters
- St. Malo
- Chinook
- Walker Ridge
- Dana Point

Thanks to Veritas (3D - PSDM)
Lower Tertiary: Drill History

Wells in the Ultra Deepwater GOM prior to 2002

- ~ 2 Dozen dry holes in the Ultra Deepwater Gulf of Mexico by 2002
- Nearly all wells penetrated Miocene and younger strata
- 2 Perdido Foldbelt wells, Baha & Trident, targeted the Lower Tertiary; finding significant clastic accumulations
Lower Tertiary: Drill History

Wells that Changed Everything

• Cascade, 2002, WR 206. Oil Discovery in the Eocene/Paleocene (Wilcox).
• Great White, 2002, AC 857. Oil Discovery in the Eocene/Paleocene (Wilcox)
Lower Tertiary: Drill History

Wells in the Lower Tertiary since 2002

- Potentially 3–15 BBOE estimated ultimate reserves (EUR)
- Approximately 2.5 BBOE have been discovered by industry in 14 discoveries

Alaminos Canyon
Keathley Canyon
Walker Ridge
Lower Tertiary: Drill History

- Texas
- Louisiana
- Continental Shelf
- Salt Province
- Mississippi Canyon
- Mexican Waters
- Walker Ridge
- Green Canyon
- Chinook
- St. Malo

Thanks to Veritas (3D - PSDM)
Agenda: Trend Characteristics
Trend Characteristics: Structural Styles

Jack Discovery
350’ Net Pay

St. Malo Discovery
600’ + Net Pay

Pay interval

25 Miles
Trend Characteristics: Structural Styles

The Perdido Fold Belt

Great White  Trident  Toledo

Autochthonous Salt  Miocene  Wilcox

Oligocene  Cretaceous

Thanks to WesternGeco (3D Time Migration)
Trend Characteristics: Seal & Source

**Seal**

- Wilcox Turbidites are overlain by thick, regional Reklaw Shale
- Wilcox is partitioned into 2 reservoirs by regional debris flow

**Source**

- Lower Tertiary Clastics are charged by Cretaceous and Jurassic source rocks
- Low GOR (<350)
- Viscosity varies significantly: 1-10+cp
- Viscosity varies vertically and laterally within structures suggesting complex filling histories
- API 22-41°
- 0-2% Sulfur
- Current reservoir pressure is >19,000 psi; Temp is >230° F
Wilcox Regional Cross Section – Alaminos Canyon to Atwater Valley

Top Wilcox
51.8 DLS
(Wilcox 1a)
55.5 SB
(Wilcox 1b)

57.5 Ma SB
(Wilcox 2)

58.5 Ma SB
(Wilcox 3)

59.2 Ma SB
(Wilcox 4)

Midway
60.0 SB
Cretaceous
65.5 SB

400 miles end-to-end

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Trend Characteristics: Reservoir

Leveed Channel Morphology
60 foot slices through flattened PSDM

- Average channel width ~ 1,000 – 1,500’
- Width of meanders ~ 4,000’ – 8,000’
- Amplitude of meanders ~ 5,000’ – 10,000’

High sinuosity meander and cut-off
Low sinuosity cut-off meander

Thanks to WesternGeco (3D Time Migration)

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Modified from Stelting, 2001

Whole core based schematic model for leveed channel systems
Trend Characteristics: Reservoir

Interpreted Depositional Environment and Analog

Analog: Tanqua – Karoo Basin, South Africa

Downdip limit of onshore well and seismic control for Wilcox

Low aspect ratio sinuous channels

Amalgamated channels (Wilcox 2)

Extensive unconfined sheet sands (Wilcox 1)

by Mooney, Zarra, and Sullivan
Trend Characteristics: Reservoir

1500 Louisiana

Wilcox 1

Wilcox 2

Avg Por: 19-23%
Avg Perm: 6-20md

C. Skirius

Stratigraphic Equivalents
Agenda: Jack Well Test
Jack Extended Well Test

• Why a well test?
  - No production from new trend
  - Low permeability reservoir
  - Thin-bedded reservoir
  - Frontier drawdowns for Deepwater GOM
  - Effectiveness of fracture stimulation
  - Lease expirations
Jack Extended Well Test

- 7,000’ of Water
- 20,000’ Under the sea floor
- Sustained a flow rate of more than 6,000 barrels of crude oil per day
- The test represented approximately 40 percent of the total net pay measured in the Jack #2 well.
- Well Flowed for 23 days
- Well test cost Chevron and partners more than $125MM
- Jack partnership “sold” data/results to industry
- Broke ~2 dozen World Records for well testing
Jack Extended Well Test

Jack #1

Upper Zone
Perfs 26,626 – 26,720’ MD (94’)

Middle Zone
Perfs 26,832 – 27,146’ MD (314’)

Lower Zone
Perfs 27,258’ – 27,385’ MD (127’)

72’ Sand Not Perforated

71’ Sand Not Perforated

Fractured Limestone 26,540 – 26,588’

Gross Thickness: 815’

Jack #2 correlative test intervals

WILCOX1

Deeper pay intervals in well were not tested

Test

Not Tested

Deeper pay intervals in well were not tested

Test

Deeper pay intervals in well were not tested
Agenda: Trend Challenges - Subsurface & Economic

[Graphs and charts showing annual net cash & earnings, and net NPV over several years.]
Damage Control

We just found the next Prudhoe Bay Baby!

Lower Tertiary Trend: A Study in the Impact of Advancing Technology

Diane Langley, JPT Features Editor
Trend Challenges: Development Options

FPSO can also be used as Early Production System.
Trend Challenges: High Cost Environment

• Sunk Capital
  ■ Jack Discovery Well (04) $80MM
  ■ Jack 2 Well (05) $124MM
  ■ Jack Well Test (06) $125MM

• Future Capital
  ■ 10-20 Development Wells (~$150MM each)
  ■ Facility Costs ($>1,000MM)
Trend Challenges: Development Complexities

• Water depths range from 5,000 to 10,000’
• Majority of play is under salt canopies (7,000’ - > 20,000’ thick)
• Complex Sub-salt imaging
• Reservoir depths range from 12,000’ – 35,000’ subsea
• >200 days to D&C each well
• Limited number of vessels to drill in ultra-deepwater
• High temp & pressure reservoirs
• Complex completions, with significant intervention costs & frequency

….But yet
Trend Conclusions

- 2-5 Billion barrels of OOIP per discovery
- Approximately 2.5 BBOE recoverable reserves have been discovered by industry
- Estimated reserves per discovery: 100 to 600 MMBO
- Estimated Trend Ultimate Recoverable Reserves: 3 – 15 BBOE
- Wildcat success rate is ~ 65%
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