Unlocking the Exploration Potential and Petroleum Prospectivity of Barbados’ Offshore Acreage

Jamar White
Director
Natural Resources Department
Division of Energy and Telecommunications – Government of Barbados
Presentation Outline

- Executive Summary
- Regional Setting
- Onshore Geology
- Offshore Exploration
- Seismic Data
- Exploration Potential and Petroleum Prospectivity
- Future Plans
- Licence Blocks
Executive Summary

• In 2007, Barbados launched its first offshore oil and gas licensing round offering 24 blocks to the industry for bidding.

• At the end of the bid evaluation period, BHP Billiton emerged as the only successful bidder, being awarded two blocks: Carlisle Bay and Bimshire.

• Since that time, Barbados’ offshore acreage has continued to attract significant interest from international oil companies.

• In 2013, the Government of Barbados through Norwegian geophysical company, MultiClient Geophysical (MCG) acquired a modern, high-quality 2D seismic dataset offshore Barbados.

• This dataset has helped to improve the understanding of Barbados’ offshore acreage and further unlock the exploration and petroleum potential of the area.
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Regional Setting

- Barbados is a small island (34km long and 23km wide) located at the leading edge of the Caribbean Plate.
- Convergent margin setting where the South American Plate is subducting below the Caribbean Plate.

- Barbados is the only emergent part of the Barbados Accretionary Prism (BAP) which is 300km wide and 20km thick.
- BAP formed via the off-scraping of sediment during subduction.
Offshore Barbados consists of three main prospective physiographic regions: Tobago Trough, Barbados Ridge and the Barbados Trough.

The island’s only offshore well, Sandy Lane, was drilled in the Barbados Trough by Conoco in 2002.

Proven petroleum system onshore Barbados along the axis of the Barbados Ridge.

Proven offshore petroleum system in neighbouring Trinidad.
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## Stratigraphy

<table>
<thead>
<tr>
<th>Series</th>
<th>Stage</th>
<th>Zone/Formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pleistocene</td>
<td>Pleistocene/Corals</td>
<td>Reef, Coral rock</td>
</tr>
<tr>
<td>Middle Miocene to Middle Eocene</td>
<td>Oceanics</td>
<td>Oceanics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pelagic and hemipelagic marls</td>
</tr>
<tr>
<td>Middle and Lower Eocene</td>
<td>Intermediate Unit</td>
<td>Intermediate Unit Sands</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intermediate Unit Shale</td>
</tr>
<tr>
<td></td>
<td>Basal Complex /Scotland Formation</td>
<td>*Upper Scotland Sands</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*Upper Scotland Basals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*Basals Shale</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*Lower Scotland Sands</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lower Scotland Shale</td>
</tr>
</tbody>
</table>

* - Reservoir Intervals
* - Seals
• 80% of the island is capped by Quaternary Limestone.

• This cap has been eroded in the NE to expose the underlying Tertiary units of the Scotland Formation, Joes River and Oceanic Formations.

• Early oil wells were drilled in this area during the 1800’s.

• Hydrocarbons currently being produced from the Woodbourne field in the SE.

Chaderton, Wood & Mann 2005
Woodbourne Oil Field

- Discovered in the 1960’s
- Total of 248 wells
- Eocene reservoir rocks
- Average 25° API oil

- Average daily oil production ~800 bbls
- Average daily gas production ~ 1900 mcf
- 10 mmbbls of oil produced
- 22.8 bcf of associated gas
Biomarker Studies

- Geochemistry of Woodbourne oils comparable to that of the Upper Cretaceous La Luna source rock

- Hydrocarbons generated from an oil prone Type II kerogen

- Source intervals have not been penetrated by onshore wells
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Conoco granted an offshore concession licence in 1996
Conducted extensive surveys offshore Barbados with piston core and seep analysis indicating oils derived from an Upper Cretaceous marine type II kerogen.
Drilled Sandy Lane 1/1Z well in 2002, 130 km south of Barbados
Deep water frontier area: 6,975 ft water depth. Well: 15,074 ft total depth
Conoco relinquished the offshore acreage in 2004
Sole offshore operator with Total SA as a partner.
Sandy Lane 1/1Z

- 3 way dip closure with lateral fault seal

- Neogene Reservoir targets: Endeavor, Single Fish and Enterprise Wedge

- Interpreted as deep marine turbidites deposited as sheets and channel complexes derived from the proto-Orinoco

- Shale overhang present in the NE

- Direct Hydrocarbon Indicators observed on seismic (amplitude brightening and flat spots)

- Well terminated in Miocene section
Post-Well Prognosis

- Dry well with gas shows
- Proved the presence of good quality reservoir rock
- Amplitude brightening on the Sandy Lane Prospect related to the presence of low saturation gas.
- Hydrocarbons had leaked from the structure, due to mud diapirism and related faulting.
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Older Seismic Data

**Conoco-Barbados 1999 and 2000 Surveys**

- 11,970 km of 2D seismic
- 500 sq. km of 3D seismic
- Good coverage over the Barbados and Tobago Troughs with less extensive coverage over the Barbados Ridge

**Wavefield-Inseis 2007 Survey**

- 8,030 km of long offset 2D seismic
- 11,500m Streamer Length
- Wavefield Inseis acquired by CGG Veritas; subsequently acquired by Spectrum ASA
New Seismic Dataset

- Acquired in 2013 by Norwegian geophysical company MultiClient Geophysical
- Modern long offset 2D seismic dataset: 6,876 km
- Streamer length: 10,500 m
- Record Length: 14 seconds
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Offshore Barbados consists of 4 main plays which were originally classified by Conoco:

- Reservoir rocks included Neogene turbidites and Paleogene submarine fans.
- Barbados Trough believed to have the highest prospectivity and lowest risk plays.
- Barbados Ridge and Inner Deformation Front Plays were viewed as high risk plays.

Barbados Trough Neogene Play:
- **Primary** – Discovery Bay
- 4-way closure
- Amplitude support at 1070
- Pliocene/Miocene Sands
- Main Risk – Charge/Hydrocarbon Type

Barbados Trough Paleogene Play:
- Prism Wedge and Intra-Prism
- 4-way closures – no breaching
- Proximal to Source
- Eocene-Oligocene Sands
- Main Risk - Reservoir

Barbados Ridge Play:
- Intra-Prism Eocene Sats
- Oil-prone structural trend
- Main Risk - Trap
- 600-1000m WD

Inner Deformation Front Play:
- Multiple 4-way leads
- Eocene-Oligocene Sands
- No amplitude support
- Primary Risk – Source
Conoco Prospects and Leads

Inner Deformation Front Leads

- Conoco identified prospects and leads within the Barbados and Tobago Troughs
- Inner Deformation Front leads: smaller 3-way and 4-way dip closures with lateral fault seals
- The Barbados Trough prospects and leads: larger 3-way and 4-way dip closures exhibiting direct hydrocarbon indicators
- Inability to identify source rock layers due to poor seismic resolution at depth
MultiClient Geophysical Seismic Dataset

• Improved outlook for the prospectivity and exploration potential of the Tobago Trough and Barbados Ridge.

• Identification of a number of undiscovered leads and prospective areas.

• Ability to map deeper horizons which were poorly imaged in previous seismic vintages.

• Structural and stratigraphic traps with new play concepts

• Possibility for source rock modelling.
Tobago Trough

- Mapping of acoustic basement and recognition of deep basins
- Identification of new leads (structural and stratigraphic closures)
- Imaging of deeper horizons
• 3-way and 4 way dip closures
• Structural and stratigraphic traps
• Direct hydrocarbon indicators (amplitude anomalies)
• Paleogene submarine fan plays and Neogene turbidite plays
• Potential mud diapir plays
Barbados Trough

- Larger 3-way and 4-way dip closures
- Lateral fault and mud seals
- Potential mud diapir plays
- Faulted anticlinal structures
- Pervasive faulting results in compartmentalization of structures
Barbados Trough

- Dip closed structures with lateral fault seals
- Fault block plays
Barbados Ridge and Barbados Trough

- Miocene DHI
- Miocene/Eocene lowstand fan/wedge in Barbados Trough

- Direct hydrocarbon indicators
- Broad anticlinal structures
- Prospective reservoir intervals in low stand fan/wedge basin fill sediments
- Structural and stratigraphic traps
Barbados Trough

- Direct Hydrocarbon Indicators
- 4-way dip closures
- Potential for stacked reservoirs with targets at numerous stratigraphic intervals
Source Rock Hunting

- Deep basin with thick sediment fill in the Tobago Trough
- Mapping of acoustic basement possible
- Can be used for basin modelling to reduce exploration risk (migration and maturation studies)
- Source rock hunting
Top Miocene Closures

Middle Miocene Unconformity Closures
Barbados Trough Geoprofile

- Potential for stacked reservoirs with multiple targets
- Structural and stratigraphic traps
- Migration along faults into structural highs and pinchouts
• Potential for stacked reservoirs with multiple targets
• Migration along faults, then updip via a fill and spill model
• Structural and stratigraphic traps
Offshore Prospectivity

- Underexplored frontier area
- Structural and stratigraphic closures identified at numerous stratigraphic levels
- Good prospectivity throughout the Barbados Trough, Barbados Ridge and Tobago Trough
- Direct hydrocarbon indicators
- Good quality reservoir rock
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Future Plans

- Reprocessing of Conoco seismic
- Attribute and amplitude analysis
- AVO studies
- Basin modelling and source rock analysis
- Additional seismic interpretation programmes
- Regional seismic surveys and infill lines
- Biostratigraphic analysis to further constrain the ages of offshore units
Future Licensing Campaigns

• The Offshore Petroleum Legislation was amended and subsequently proclaimed in 2013, allowing for the award of offshore licences via bid rounds or direct negotiations.

• Government is currently preparing pre-qualification criteria and bidding guidelines which will be utilized for the next licensing campaign.

• This information will be disseminated to the industry in the coming months and will outline a clear process for the future award of licences.
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Available Offshore Blocks

Total acreage: 70,191 km²
Total number of blocks: 26
Total number of available blocks: 22

Average size: 2,700 km²
Max size: 5,025 km²
Min size: 790 km²

* 4 excluded blocks: A-Moses, Oistins, Carlisle Bay & Bimshire
## Bid Blocks

<table>
<thead>
<tr>
<th>Block Name</th>
<th>sq. km</th>
<th>Block Name</th>
<th>sq. km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ea-II, Eb-I Road Tennis</td>
<td>2,550</td>
<td>Ca-II Paynes Bay</td>
<td>2,498</td>
</tr>
<tr>
<td>Ea-IV Six Mens</td>
<td>2,089</td>
<td>Cb-I Oistins*</td>
<td>2,498</td>
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<tr>
<td>Eb-III River Bay</td>
<td>2,470</td>
<td>Cb-II Carlisle Bay*</td>
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<tr>
<td>Da-I, Ea III Speightstown</td>
<td>790</td>
<td>Cc-I, Cc-II Kensington</td>
<td>4,996</td>
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<tr>
<td>Da-II Black Belly</td>
<td>2,479</td>
<td>Ca-IV Man Jack</td>
<td>1,342</td>
</tr>
<tr>
<td><strong>Db-I A-Moses</strong>*</td>
<td>2,445</td>
<td>Bb-I, Cb-III Flying Fish</td>
<td>2,772</td>
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<tr>
<td>Db-II Green Monkey</td>
<td>2,479</td>
<td><strong>Cb-IV Bimshire</strong></td>
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<tr>
<td>Da-III Mullins Bay</td>
<td>1,242</td>
<td>Cc-III, Cc-IV Chattel House</td>
<td>5,013</td>
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<tr>
<td>Da-IV Holetown</td>
<td>2,489</td>
<td>Bb-II Steel Donkey</td>
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<tr>
<td>Db-III Bridgetown</td>
<td>2,093</td>
<td>Bc-I, Bc-II B 4362 Sugar Cane</td>
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</tr>
<tr>
<td>Db-IV Bajan Cherry</td>
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<td>Bc-III, Bc-IV Tuk Band</td>
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<tr>
<td>Ed-III, Ed-IV Bathsheba</td>
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<td>Bd-III, Bd-IV Crane Bay</td>
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<tr>
<td>Ca-I, Ca-III Pelican</td>
<td>1,166</td>
<td>Ad-I, Ad-II Bottom Bay</td>
<td>2,027</td>
</tr>
</tbody>
</table>

* *Unavailable Blocks*
Contact Information

AAPG International Pavilion Booth #: 552

Mr. Jamar White – Director, Natural Resources
Email: jwhite@energy.gov.bb
Tel: (246) 434 2507

Website: www.energy.gov.bb

Division of Energy and Telecommunications
Trinity Business Centre
Country Road
St. Michael
Barbados
West Indies
Special Thanks

MultiClient Geophysical

Exploro Geoservices
Thank You