Atlantic Conjugate Margins
An Exploration Strategy

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Introduction

• Why the Conjugate Margin?

• Equatorial Conjugate Margin

• Conjugate Margin Seismic Reconstruction

• South Atlantic Seismic Reconstruction

• North Atlantic Seismic Reconstruction

• Conclusion
Conjugate Margins are not a new concept!!!

**Oil and Gas Companies**
- Defined play concepts
- Prolific reserves
- Large playground
- Opportunities
  - Open blocks or Farmins
- Business strategy and investment capital

**Governments**
- Regional Basin Geology
- Licence Round Direction
- Facilities and Infrastructure
- Reserves = Government Revenue
Benefits of a Conjugate Margin Exploration Strategy to an Oil Company

- Focused play concept fairway
- Focused prospect strategy (open blocks or farmin blocks)
- Focused growth of prospect inventory
- Focused international business plan to raise international capital
EQUATORIAL MARGIN
Equatorial Conjugate Margin Successes
Hihon & Fifa (2002)
Sub-Commercial oil
Albian Sst

Seme (1968)
STOOIP 250 MMB
Turonian & Albian Sst

Aje (1996)
Recov. 200 MMB
Turonian Sst

Lome (1970)
432 bopd
STOOIP 80 MMB
Neocomian Sst

Jubilee (2007)
1 billion bbls in Turonian Sandstone
Tweneboa 300mmb+
Enyenra 300mmb+

Baobab (2001)
200mmb in Albian sandstone

Tar sand belt
doil sourced from Lower Cretaceous, similar to lacustrine source rocks
Transform Margin Regional Development
The main Oceanic Fracture Zones are controlling the tectonic development on the Equatorial Margin.

Source: Modified from NUPETRO, 2003
Jubilee Field/Discovery Analogue

- Discovered 2007
- WD 1,300-1,500m
- Reserves: 1200 mmbbl
- Turonian fan sands
- High rate reservoir
- Oil Gravity 37° API
- First oil December 2010 60,000 BOPD
- Tullow est gross resource upside potential 4Bn bbls

From Tullow 2010 Full Year Results Presentation March 2011
Jubilee Field

After Tullow/Anadarko

Series of turbidite fans and channels of Campanian to Turonian age

Line of section
Fault/pinchout

Down-dip Class III AVO switch-off @3650mss

Reservoir

Seismic Line
Attribute (Far Envelope – Near Envelope) x Far Envelope
Post-Transform Turbidite Fan Play Fairway

Venus 1

VENUS B1

WD: 1,798m  TD: 5,639m

Turonian channel / fan play
13.7m net hydrocarbons in Turonian channel / fan.

Well proved several mature oil-prone source rocks.
Cingulata Fan System offshore French Guiana tested by our Zaedyus wildcat >6,000 mTD
- 72m of net oil pay discovered; sidetrack underway now to gather further data
Prospects and Structure

French Guiana – 3D seismic reveals Jubilee type fans

- Structural focus like Tano nose
- Turbidite feeder canyon
- Large turbidite fans like Jubilee
- Fan systems like Tweneboa-Owo-Ntomme

- 2,500 sq km 3D seismic survey acquired in 2009/2010
- Very good quality data set with many similarities to the Jubilee 3D seismic surveys
- Large fan features identified on regional 2D grid are being worked in detail in 3D
Aje Field

- Discovery year: 1996
- First Well: Aje-1
- Oil in place: 200 MMbbl
- Gas in place: 750 BCF
- Age of reservoir: Cen-Turonian

Dip line through Aje and GeoStreamer NTM 3D

OML 113 MC3D

Nigeria Transform Margin MC3D
Dip line through Aje and GeoStreamer NTM 3D

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- Albian tilted fault blocks
- Albian anticlinal draped sandstones
- U Cretaceous channel & fan pinchouts
- U Cretaceous deepwater sandstones
- Paleocene ponded turbidites
- Paleocene deep water fans
- Oligo-Miocene unconformity
- Top Cretaceous
- Late Albian unconformity

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OML 113 MC3D
Nigeria Transform Margin MC3D
Fan Feature (Amplitude Anomaly)
Fan feature (AVO)

Far stack
Mid stack
Near stack
CONJUGATE MARGIN
SEISMIC RECONSTRUCTION
The construction of regional and global plate tectonic models is critical to understanding a wide range of geological processes such as basin dynamics, margin evolution and palaeo-environment development.

Plate models allow visualisation of regions that have undergone deformation and re-activation over time.

Integration of these elements enables identification and evaluation of petroleum systems and mineral resources.

We employ an integrated methodology in which plate modelling is based on structural interpretation and forms a framework for palaeogeographic modelling. The plate model is then refined using palaeogeographic interpretations.
GETECH’s global plate model currently comprises over 11,600 plate polygons:
- Over 550 plate polygons represent continental, transitional and other non-oceanic crust.
- The remaining polygons represent oceanic crust; using a large number of oceanic polygons allows us to accurately represent recent (< ~180 Ma) seafloor spreading histories.

GETECH’s plate polygon set is underpinned by detailed structural mapping from gravity & magnetic potential field data, SRTM digital elevation models, seismic cross sections, geological maps and other remote sensing data:

Each plate polygon has been assigned a plate ID number that is used to describe its relative motion over time. This allows us to build up a detailed history for each plate, within a global framework.
Preliminary Scope of Study

- Use PGS seismic database
- Getech to use their Global Plate Model to reconstruct seismic data
- Reconstruct Time data
- Confirm Matching Geology of Conjugate Margin
- Re-input into Global Plate Model
PGS MultiClient Data - South Atlantic

**BRAZIL**
200,000 km² 3D
300,000 km 2D

**WEST AFRICA**
180,000 km² 3D
35,000 km 2D
Getech provides the Global Plate Model which has information on basin geodynamics, juxtaposition of play elements, boundary conditions for paleo-geographic mapping and reconstruction of exploration data (including seismic).
Seismic Reconstruction Present Day
Seismic Reconstruction 100 Ma
Seismic Reconstruction 110 Ma
Seismic Reconstruction 120 Ma
Brazil/Angola - Aptian 120 Ma
SOUTH ATLANTIC SEISMIC RECONSTRUCTION
South Atlantic Conjugate Margin Successes
Aptian 120 Ma
Brazil – Gabon Preliminary Time Reconstruction

Aptian 120 Ma

Salt

Brazil 2D Conventional Line
Gabon MegaSurvey
Brazil – Angola Preliminary Depth Reconstruction

Lula - Tupi

Salt

Santos Basin GeoStreamer 2D Depth Line

Namibe Basin GeoStreamer 2D Depth Line

Published Tupi Section

PGS Geostreamer Tupi Line
NORTH ATLANTIC SEISMIC RECONSTRUCTION
North Atlantic Conjugate Margin Successes

PGS Data
60,000 km 2D
10,000sq km 3D
Regional Structure

- **South Rockall Basin**
- **Hatton Basin**
- **Northeast Rockall Basin**
- **North Rockall Basin**
- **Porcupine Basin**
- **Rockall Basin**
- **South Rockall Basin**
- **Northeast Rockall Basin**

Faults/Lineaments, Volcanic Provinces (PAD and PESGB)

Base Tertiary TWT Structure Map (Contour Interval = 1s)

- **TWT (secs)**

Legend:
- Landscale Parcels
- Mesoic Basin
- Carboniferous Basin
- Early Palaeozoic Basin

Scale: 260 km
Mid-Aptian Structural Elements and Basins

Irish Petroleum Affairs Department, 2011
Scotian Grand Banks Jurassic Reefs

Recoverable Reserves of Gas
632 BCF
Regional Abenaki Reef Trend

From Nova Scotia Government Public Information
Baltimore Canyon Jurassic Reef

Jurassic Aged Reef

Dunquin - South Porcupine Basin
Carbonate Buildup on Volcanic Ridge

Upper Jurassic

ABENAKI
Nova Scotia
Baltimore Canyon

Reefs & oolites

Siliceous sponge reef belt
Tethys Ocean

Jurassic
East Coast Canada – Irish Sea Atlantic Margin
Preliminary Time Reconstruction

Jurassic tilted fault blocks and Jurassic syn-rift basins
CONCLUSION
Conclusion

• Significant opportunities in the North Atlantic, Equatorial and South Atlantic Conjugate Margins

• Benefits to existing Operators

• Benefits to Governments

• New business plan capital investment strategy
• Balance seismic displays in phase and amplitude.

• Generate more time and depth reconstructions along South Atlantic Conjugate Margin.

• Template proven South Atlantic Conjugate Margin Discoveries
  Brazil–Tupi / Angola–Maersk, Cobalt
  French Guiana–Zaedyus Tullow
  Ghana–Jubilee Tullow

• Prospectivity trends of Conjugate Margin Plays.
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Thank You!