Deepwater exploration potential in Equatorial Guinea

Abhen Pather, Steve Lawrence, *Chris Cornford and *Andrew Mort

RPS Energy, 309 Reading Road, Henley-on-Thames, Oxfordshire, RG9 1EL, UK

* IGI Ltd, Hallsannery, Bideford, Devon, EX39 5HE, UK
Outline of Talk

1. Introduction
2. Regional Geology and Geochemistry
3. Rio Muni basin
   - well and seismic data
   - basin modelling
   - migration paths
4. Distal Niger Delta & Outer Douala basins
   - basin modelling
   - migration paths
5. Petroleum Systems Summary
6. Conclusion
1. Introduction
• Offshore focus

• Deepwater plays
(sub - 1000m water depth)

• Large open licence block area

• Positive indications from deepwater exploration carried out to date
1. Regional Geology & Geochemistry
Regional geology

Key features:

- Basinal elements
- Cameroon Volcanic Line
- Crustal variation
  - Oceanic (OC)
  - Proto-oceanic (POC)
  - Rifted continental (RCC)
- Oceanic Fracture Zones
Interpretation of LO-7 Seismic Profile
Geochemistry Samples

- 19 new oil samples
- 18 new source rock samples
- Results combined with pre-existing Principe, Sao Tome and Cameroon data
Geochemistry

Source rocks:
- richness
- quality

- High resolution geochemical analysis
- Multiparameter Oil - SR fingerprinting

4 Oil families linked to 4 major source rock horizons
2. Rio Muni basin

- well and seismic data
- basin modelling
- petroleum migration
Deepwater well L-2

Water depth ~2000m

Mud log – Banyan L-2

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Cuttings (%)</th>
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<tbody>
<tr>
<td>12350ft</td>
<td>3765m</td>
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Lithology Description

- SAND/SHALE: quartz, light grey, white, cream, transparent very fine to fine, occ medium grained, sub-angular to sub-rounded, moderately sorted, weak calc cement, efflorescent matrix, traces of clay and pyrite, spotted out yellow thin thin, occasional small dull yellow cut from 12240-12250ft and at 12370ft.
- FLUORESCENCE: grey to dark grey, occ greenish, moderately hard, amorphous, sub-blocky to blocky, slightly silty, occ glassy to cutaneous.
Seismic section along Rio Muni

Feeder channel along basin margin

A

B
Campanian Amplitude anomalies

Large channel ~2km wide in western Kribi sag

Kribi Fracture Zone

Channelised fan?

Small 200m across NW-SE Shoe-string channels

Base Tertiary Mid-point of 50 msec window above Base Campanian
Aptian-Albian source rock maturity

Present Day

10 Ma

55 Ma

35 Ma

Maturity VR LLNL (%Ro)

- Early Mature (oil)
- Mid Mature (oil)
- Late Mature (oil)
- Main Gas Gen
Albian-Turonian source rock maturity

Maturity VR LLNL (%Ro)
- Early Mature (oil)
- Mid Mature (oil)
- Late Mature (oil)
- Main Gas Gen

Present Day

15 Ma

35 Ma

25 Ma
Line-07 OIL & GAS 2-D model

**GAS at present day**

- **Seabed**
- **Base Tertiary**
- **Base Albian**

**Oil Saturation (fraction)**
- 0.05
- 0.2
- 0.4
- 0.6
- 0.8
- 1

**Gas Saturation (fraction)**
- 0.05
- 0.2
- 0.4
- 0.6
- 0.8
- 1

**Oil Saturation Cross Section at Present Day**

**VE = 10.1**

**OIL at present day**

- **Seabed**
- **Base Tertiary**
- **Base Albian**

**Oil Saturation (fraction)**
- 0.05
- 0.2
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- 1

**Gas Saturation (fraction)**
- 0.05
- 0.2
- 0.4
- 0.6
- 0.8
- 1

**Oil Saturation Cross Section at Present Day**

**VE = 10.1**
Migration paths

Stop-start charge

Continuous charge

SR3

SR2

CEIBA

OVENG-OKUME

G-4

OC

POC

RCC
3. Outer Douala - Distal Niger Delta Petroleum Systems

- basin modelling
- petroleum migration system
Oligocene-Miocene source rock maturity

Present Day

2 Ma

10 Ma

5 Ma

Maturity VR LLNL (%Ro)
- Early Mature (oil)
- Mid Mature (oil)
- Late Mature (oil)
- Main Gas Gen
Modelled OIL & GAS along seismic Line-3

GAS at present day

- Seabed
- Base Tertiary
- Base Albian
- SE

Gas Saturation (fraction)
- 0.2
- 0.4
- 0.6
- 0.8
- 1

Oil Saturation (fraction)
- 0.01
- 0.2
- 0.4
- 0.6
- 0.8
- 1

VE = 6.03

OIL at present day

- Seabed
- Base Tertiary
- Base Albian
- SE

X Distance (m)
- 0
- 20000
- 40000
- 60000
- 80000
- 100000
- 120000

Depth (m)
- 0
- 2000
- 4000
- 6000
- 8000
- 10000
- 12000

Ve=6.28
4. Petroleum Systems Summary
Rio Muni South Petroleum Systems

Santonian-Campanian reservoirs charged by Aptian-Albian SRs
Santonian - Campanian reservoirs charged by Albian-Turonian SRs
Petroleum Systems Summary

- APTIAN - ALBIAN SR
- Albian - Turonian SR
- Pre- & post-Campanian age sandstone reservoirs
Miocene reservoirs charged by Tertiary SRs
Distal Niger Delta Petroleum Systems

Miocene to Pleistocene sandstone reservoirs charged by Tertiary SRs
Petroleum Systems Summary

Basement fracture control on reservoirs
CONCLUSION

- Evidence for working deepwater petroleum system in wells such as L-2
- Seismic evidence for sandstone reservoirs in deepwater distal portions of basin
- 4 oil families linked to 4 major source rocks
- Basin modelling indicates main ‘kitchen’ area in deepwater portions with potential for CONTINUOUS charge by updip migration &/or vertical migration along BFZs
- Potential for more oil &/or gas in deepwater offshore EG