West Africa
Deep water Nigeria: Definition of stratigraphic plays

The Royal Institution
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Overview of Presentation

- Rationale
- Geology of deep water sedimentary basin
- Existing fields and discoveries
- Deep water sedimentary systems
- Examples from recent GCA study
- Summary and conclusions
Rationale

- Focus of recent West Africa exploration on the pre-Salt and on Upper Cretaceous plays, especially on the transform margin
- Recent Nigerian discovery at Ogo in the Albian-Turonian play
- But is there a reason for looking again at the deep water delta blocks?
Regional Structure

Bakare et al., 2010

Ejadawe, 2012
Regional Stratigraphy

B

Deltaic

Continental

Basinal turbidite sands

Zone of slope channels

Mud-dominated delta front

Ejadawe, 2012
## Existing Fields

<table>
<thead>
<tr>
<th>Field</th>
<th>Reservoir</th>
<th>Trap</th>
<th>Disc</th>
<th>Depth</th>
<th>Reserves</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erha</td>
<td>Miocene</td>
<td>Anticline</td>
<td>1999</td>
<td>1200m</td>
<td>500 MMBO + 3.2 TCF</td>
<td>30-32°API oil</td>
</tr>
<tr>
<td>Bosi</td>
<td>Miocene</td>
<td>? Combined structural-stratigraphic trap</td>
<td>1996</td>
<td>1424m</td>
<td>683 MMBO + 2.3 TCF</td>
<td></td>
</tr>
<tr>
<td>Oberan</td>
<td>Miocene</td>
<td>Faulted anticline</td>
<td>2002</td>
<td>900m</td>
<td>93 MMBOE</td>
<td>HPHT 157°C, 10800psi</td>
</tr>
<tr>
<td>Bonga/Bonga SW</td>
<td>Miocene</td>
<td>Fault block / flank of mud diapir</td>
<td>1995</td>
<td>1311m</td>
<td>1235 MMBO + 951 BCF</td>
<td></td>
</tr>
<tr>
<td>Nsiko</td>
<td>Miocene</td>
<td>Thrusted anticline</td>
<td>2003</td>
<td>1812m</td>
<td>289 MMBO</td>
<td></td>
</tr>
<tr>
<td>Agbami</td>
<td>M Miocene - Oligocene</td>
<td>Partly sub-thrust anticline, cored by reverse fault / mud diapir</td>
<td>1998</td>
<td>1463m</td>
<td>780 MMBO + 576 BCF</td>
<td>35-45° API oil. Low sulphur</td>
</tr>
<tr>
<td>Nnwa</td>
<td>Miocene</td>
<td>Thrusted anticline</td>
<td>1999</td>
<td>1200m</td>
<td>4.4 TCF + 200 MMBO</td>
<td>Gas</td>
</tr>
<tr>
<td>Akpo</td>
<td>Miocene</td>
<td>Anticline/minor strat component</td>
<td>2000</td>
<td>1400m</td>
<td>590 MMBO + 1.2 TCF</td>
<td>50° API condensate</td>
</tr>
<tr>
<td>Usan</td>
<td>Miocene</td>
<td>Complex structure in eastern deformed belt</td>
<td>2002</td>
<td>750m</td>
<td>450 MMBO</td>
<td>21-42° API oil</td>
</tr>
</tbody>
</table>

Various sources. Reserves data in part from Weimer, 2004, originally sourced from IHS
Existing Fields

AKPO: CNOOC, 2006

Optimum drilling location not necessarily on crest of structure

BONGA: Chapin, 2002

BONGA: van Hoorn, 2012
Deep Water Sandstone Depositional Model

After van Hoorn, 2012
• Importance of stacked pay in confined settings to provide reservoirs of material significance.
• Structural and sedimentary confinement of sand deposition
Combined Structural-stratigraphic Trap Models

After Matthew et al., 2010

Syn-depositional structural growth, channel control and confinement

Incision of channel

Possible updip limit of channel sandstones

Stratigraphically trapped slope and BFF reservoirs within structural nose

Deepwater Thrust Stratigraphic Play

*Not to scale
Examples

▪ Prospect evaluation offshore Nigeria
▪ Permissions have been granted by client, but location and identity to be maintained confidential
▪ Close calibration of seismic response in context of sedimentary/structural models permits assessment and risk analysis
  – Sedimentary-structural models
  – Seismic geometries
  – Volume-based seismic attributes
▪ Additional methods used
  – Detailed analysis of DHI
  – Acoustic impedance volume
  – AVO
  – Detailed horizon attribute characterisation
Examples

• Examples from proprietary client dataset have been deleted from this version of the presentation
Deep-water resources

- Next generation structural traps
  - Bobo (250MMBOE contingent resources)
  - Echim (up to 186MMBOE “proven resources”)
- Next generation stratigraphic traps
  - Up to c. 200MMBO unrisked prospective resources

- Total deep water probable reserves/contingent resources
  7000 MMBO + 22.7 TCF (Steele, 2006)
Conclusions

- Significant deep-water resources are potentially associated with confined, stacked sand systems, controlled by:
  - Mud diapirs
  - Active contractional deformation
  - Erosional canyons/valleys

- Close calibration of seismic response in context of sedimentary/structural models permits de-risking
Reference list

  


- Pettinghill, H.S., Undated. Global overview of deepwater exploration and production.
  http://www.colorado.edu/geolsci/courses/GEOL6330/AAPG%20Studies%2057/Global%20DWOverview.pdf

  https://www.hgs.org/civicrm/event/info?id=395&reset=1


Thank you

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