The Hydrocarbon Potential of the Devonian Saltpond Basin offshore Ghana

Technical Session
By
Michael N. A. Aryeetey, GNPC

Accra Conference Centre
April 8, 2014
Presentation Outline

• Introduction
• Sedimentary Basins offshore Ghana
• Regional Tectonic Setting
• Basin Overview
• Data Coverage
• Stratigraphic Summary
• Petroleum System
• Reservoir Potential
• Structural Styles
• Historical Development (Saltpond Field)
• Current Activities
• Remaining Opportunities
• Conclusions
Ghana - Location
National Oil Company established in 1983; and given legal backing by two main statutes i.e. PNDC Laws 64 and 84

Vision: To be a leading global oil and gas company whose operations have a profound impact on the quality of life of the people of Ghana.

Mandate:
1. To accelerate the promotion of petroleum exploration activities to ensure early commercial discovery and production
2. To undertake the appraisal of existing petroleum discoveries to ensure production to meet national requirements
3. To ensure that Ghana obtains the greatest possible benefits from the development of its petroleum resources
4. To obtain the effective transfer to Ghana of appropriate technology relating to petroleum operations
5. To ensure the training of citizens of Ghana and the development of national capabilities in all aspects of petroleum operations and;
6. To ensure that petroleum operations are conducted in such a manner as to prevent adverse effects on the environment, resources and people of Ghana.
<table>
<thead>
<tr>
<th>Basin</th>
<th>Age of Sediments</th>
<th>Wells Drilled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tano-Cape Three Points</td>
<td>Cretaceous</td>
<td>127</td>
</tr>
<tr>
<td>Saltpond</td>
<td>Devonian</td>
<td>19</td>
</tr>
<tr>
<td>Accra-Keta</td>
<td>Cretaceous -Tertiary</td>
<td>14</td>
</tr>
<tr>
<td>Voltaian</td>
<td>Precambrian-Paleozoic</td>
<td>1</td>
</tr>
</tbody>
</table>
The tectonic controls on Devonian sedimentation are complex, but it is believed that sedimentation predate the opening and spreading of the Atlantic Ocean and divergence of the African and South American plates.

Prior to the opening of the Equatorial Atlantic, sedimentary rocks of the pre-rift stage, rocks older than Middle Albian were deposited conformably, and in their undisturbed stage mimicked the profile of the seafloor on which they were deposited.
Lithospheric stretching triggered by convective currents in the mantle caused the pre-rift sediments together with the paleo-continental crust to fail by brittle fracture producing blocks faulting (graben and horst) in the Paleozoic sediments.
Basin Overview

- The structural framework of the basin is represented by a complex set of faults-bounded grabens and horsts.

- The basin is dominated by the Romanche Fracture Zone which restricted the development of the deepwater.

- The continental shelf is relatively narrow in the east but broadens considerably in the west (from 50km to about 85km).
Seismic Data Coverage

2D & 3D Seismic Coverage
## Seismic Data Coverage

<table>
<thead>
<tr>
<th>Seismic Vintage-Year</th>
<th>Coverage/Length (km)</th>
<th>Av. Grid: Strike X Dip (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSI-82</td>
<td>7,250</td>
<td>14 x 6</td>
</tr>
<tr>
<td>JNOC-87</td>
<td>4,472</td>
<td>3 x 5</td>
</tr>
<tr>
<td>GNSB-88</td>
<td>490</td>
<td>2 X 4</td>
</tr>
<tr>
<td>GNSB-92</td>
<td>192</td>
<td>1 X 0.8</td>
</tr>
</tbody>
</table>
Well Database

Total of twenty-six (26) wells
• 6 development wells;
• 3 appraisal wells; and
• 17 exploratory wells.
Stratigraphic Summary

- Tensional stresses caused the mantle to fail by elastic flow with a subsequent upward flow of mantle sediments (dolerite) during the Triassic & Jurassic (indicating onset of rifting)

- The stratigraphy ranges from Paleozoic pre-rift sediments, through a Lower Cretaceous rift sequence to younger open marine sediments

- Devonian-sourced hydrocarbons are trapped in Devonian structural highs (horst)

- Upper Cretaceous sediments are completely eroded or absent on the Saltpond High, but there exists the possibility of encountering Upper Cretaceous sediments on the downthrown side of the southern NE-SW fault, as seen in the increased thickness of Lower Cretaceous (Aptian) sediments in the Signal 13-1 well.
Petroleum Geology of Saltpond Basin

**RESERVOIR**
- Devonian sandstones
- Triassic-Jurassic Lower Sekondi and Lower Cretaceous sandstones
- Porosity: 12-20%; Permeability: 40-500 mD, average > 100 mD

**SOURCE**
- Devonian shales;
- Lower carboniferous shales and Lower Cretaceous shales
- TOC: 3.5-4.0 %

**SEAL**
- Devonian-Lower Carboniferous Takoradi Shales (proven continuous seal over Saltpond Field); Lower Cretaceous interbedded shales

**TRAPS**
- Mainly Structural; Stratigraphic, and Combination Traps possible
Reservoir Potential

- Three formations below the Jurassic dolerite display varying degrees of reservoir properties.
- Takoradi Formation is the only proven oil and gas reservoir in the Basin.
- The Sekondi Sandstone has good porosity and permeability, but only one well Seago 10-2 reported oil shows.

- The Takoradi Formation is of Lower Devonian to Lower Carboniferous age and consists of Upper and Lower Takoradi.

- The Upper Takoradi is constituted by the Upper Takoradi shale and Upper Takoradi sandstones (A-sands).

- The A-sands is divided into A1 and A2.

- The Lower Takoradi consist of the Lower Takoradi shale and Lower Takoradi sandstones (B-sands and basal sands). The B-sands are divided into five sub-units and the Basal sands into two sub-units.

- The sands are thin, inter-fingerling with each other and frequently changing facies to tight siltstones and shales.
The Saltpond High accumulation is split into two reservoir zones: the first is located in the Upper Takoradi sands and has a gas-oil contact (GOC) at 7,530 feet subsea and an oil-water contact (OWC) at 7,665 feet subsea; and the second is found in Lower Takoradi sands, and has contacts (GOC) and (OWC) at 8,300 and 8,480 feet subsea, respectively.
Structural Styles

Figure 9. Generalized stratigraphic column showing age, lithology, tectonic stage, and stratigraphic position of selected formations in major basins (see fig. 1) of the Gulf of Guinea Province. Modified from Kiger and others (1992).
Historical Development (Saltpond Field)

- The Saltpond Field is located 12km offshore Saltpond Town.
- The field covers a surface area of 5 sq. km and in a water depth of 26 metres.
- It was discovered in 1970 by Amoco/Signal group.
- The well tested light oil (API 37°) from Upper Devonian Takoradi Sandstones.
- Gross hydrocarbon column is 162 feet, found in the 10-A4 well.

Mr. Louie Production Platform
Historical Development (Saltpond Field)

- The Field is located on a NW-SE trending horst block with numerous local faults which sub-divide the horst into minor blocks.

- In 1977/78 Agri-Petco drilled six (6) appraisal and development wells from a centrally located Jack-Up rig.

- Five of the appraisal wells were deviated from APG 10-1A. The Jack-Up was converted into a production unit and the field was put on stream in October 1978.

- The OHIP was 34 MMstb of oil, 34 Bscf of solution gas and 22 Bscf of free gas-cap.
Historical Development (Saltpond Field)

- Commercial production commenced October 1978, reaching a maximum level of 4,800 BOPD but experienced continuous decline reaching 750 BOPD in 1984.

- The field was shut-in in 1985 when production had declined to 580 barrels per day.

- The cumulative production at the time of shut in was 3.57 million barrels of oil and 14 billion cubic feet of gas had been flared.

- It was estimated that the remaining reserves is about 1.2 million barrels of oil (mmbo) and 20 billion cubic feet of gas.
Offshore Activity Map – Available Acreages
Conclusion

- High quality, regionally extensive 2D seismic, well control, and well defined hydrocarbons system (Producing Field)
- Large number of untested prospects

- Exploration potential is very high in the central basin of offshore Ghana.
- Current E & P efforts aimed at interpreting and updating existing data are ongoing.
- 3D seismic acquisition have become a key GNPC priority.
- Current E & P efforts aimed at promoting the Blocks to technically and financially competent Oil & gas companies in the industry
- Good and negotiable fiscals regimes that encourage the development of marginal discoveries
- Over 10,000 sq km of acreage available for licensing offshore.
Thank you