Lake Albert Rift Basin – Exploration Campaign
Lake Albert Rift Basin Exploration - Presentation Outline

Lake Albert Rift Basin Geology
- Regional setting
- What is a Rift Basin?
- Petroleum system
- Early exploration history

Current Exploration Campaign
- Acreage
- Basin-wide strategy

Building blocks for threshold export volume
- Prospect funnel
- Building blocks

Exploration Summary
- Strategy
- Resource volumes
Lake Albert Rift Basin Geology
Regional Setting: East Africa Rift System

- Linked intra-continental Rift Basins
- 3500 km long, 50-150km wide
- Two dominant trends; eastern and western branch
- Eastern branch, initiated Early Miocene (20 Ma), is more volcanic
- Western branch, initiated during Late Miocene (10 Ma), contains lakes e.g. Lake Malawi, Lake Tanganyika and Lake Albert
Regional Setting: Topography, rivers & lakes

- Nile Valley
- Lake Albert
- Lake Edward
- Lake Victoria
- Ruwenzori (16,761 ft) permanent snow

Courtesy Chris Scholz, Syracuse University
Rift Basins

- Separation of tectonic plates above deep-seated plumes of magma
- Brittle upper crust is faulted creating traps for oil
- Earthquake activity
- Magma feeds volcanoes
- Rift valleys form and are filled by lakes and sediments
- Heat and burial matures organic rich shales which expel oil into reservoir sands
Earthquakes and Volcanoes in East Africa Rift System

- Earthquakes influence lake water levels, topography and sedimentation
- Volcanoes influence heat flow, oil source rock maturation and CO$_2$
Lake Albert Rift Basin Shales: Source Rocks

Waki-1 (1937)

Turaco-1 (2001)

Shallow section:
Land plant dominated potentially gas generating source rock
Generally immature

Deeper section:
Amorphous algal dominated oil generating source rock
Generally mature

6-7% organic content in bituminous shale below 750m with some extractable oil

“Asphaltic oil” at 1173 m

Asphaltic oil” at 1173 m
Lake Albert bathymetry map mimics depth to source rock kitchen
• Abundant surface oil seeps (no sulphur, waxy, 30-34° API in wells)
• "Synthetic Aperture Radar" (SAR) slicks on lake
Lake Albert Rift Basin Environments of Deposition

- Braidplain - beaches
- Rift scarp cut by wadis
- Incised channel system. Main input point in basin
- Apron fan
- Active fault system
- Small Incised channel system
- Delta with associated reservoir facies
Lake Albert Rift Basin Reservoirs

- Diverse environments of deposition
  - Scree / apron fans
  - River channels
  - Deltas
  - Beaches and bars
  - Submarine fans

- Generally thick well sorted sandstones
- Good porosities (27-32%)
- Good permeability (200-8,000 mD)
- High flow rates (800-4,500 bopd)
- Multiple pay zones
- Upside reservoirs
  - Thin beds below resolution of wireline logs
  - Weathered basement / ‘granite wash’
Laterally extensive shales deposited in lakes provide top seals to reservoirs.
Trap Types in Lake Albert Rift basin

- Structural folds and noses trapped against rift boundary faults
  - Proved by Waraga / Mputa / Kingfisher – sealed against basement – de-risked
  - Present all along basin bounding faults
- Upthrown and Downthrown fault traps
- Upside play in fractured / weathered basement (yet to be successfully flow tested)
• Channel sand stratigraphic traps in buried valleys incised into basement
• Demonstrated at Mputa 2
• Kaiso Tonya 3D will show distribution of these incised valleys and channel sands
Trap Types in Lake Albert Rift basin

- Nearshore material traps associated with major basin faults
- Basin noses trapped against basement
- Submarine fans & stratigraphic traps
- Shallow simple folds offshore, some with amplitude anomalies
- Tilted fault blocks and horsts below the lake and in Butiaba-Paraa

Legend:
- Yellow: Sandstone (reservoir)
- Grey: Shale (source rock / seal)
- Red: Gas
- Green: Oil
- Pink: Basement (seal)
Trap Types in Lake Albert Rift basin

- Sandstone (reservoir)
- Shale (source rock / seal)
- Basement (seal)
- Oil
- Gas
Uganda PEPD Vision

- Over some 20 years visionary Ugandan leaders and geologists recognised the oil potential of the Lake Albert Rift Basin
- Foresight based on
  - Fundamental surface geology
  - Surveying and mapping
  - Sampling of seeps
  - Interpretation of Waki-1 (1938)
  - Analogue basins
- Young earth scientists developed in Uganda and at Universities overseas
- Consequence of vision and affirmative early plans and actions means the PEPD is a very capable technical partner
<table>
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<tr>
<th>Year</th>
<th>Block 3</th>
<th>Block 2</th>
<th>Blk 1</th>
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<tr>
<td>2001</td>
<td>$3.4m</td>
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<td>Farm in Block 3</td>
<td>2D acquired Over Lake Albert</td>
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<tr>
<td>2002</td>
<td>$3.4m</td>
<td>2D acquired Over Block 3</td>
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<td>Turaco-1 Drilled</td>
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<td>2004</td>
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<td></td>
<td>Over Turaco</td>
<td>Turaco-3 Drilled</td>
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<td>2005</td>
<td>$11.1m</td>
<td>2D acquired Over Kingfisher</td>
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<td>Kingfisher-1 Tested Seismic campaign</td>
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<td>2007</td>
<td>&gt;$100m</td>
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<td>Block 1 signed</td>
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- **Block 3**
  - Farm in Block 3
  - 2D acquired Over Block 3
  - Turaco-1 Drilled
  - Turaco-2 Drilled
  - Gas discovery
  - 3D survey acquired Over Turaco
  - Turaco-3 Drilled
  - Co2 discovery
  - 2D acquired Over Kingfisher
  - Kingfisher-1 Drilled
  - Oil discovery

- **Block 2**
  - Farm in Block 2
  - 2D acquired Over Lake Albert
  - 2D acquired Over Kasio-Tonya

- **Blk 1**
  - Block 1 signed
  - Waraga-1 Drilled
  - Oil discovery
  - Mputa-1 Drilled
  - Oil discovery
  - Nzizi-2 Drilled
  - Oil discovery
  - Mputa-3 Drilled
  - Oil discovery
  - Mputa-4 Drilled
  - Oil discovery
  - Nzizi-1 Drilled
  - Oil discovery
  - Ngassa Drilling
  - Seismic campaign
Current Exploration Campaign
Basin-wide strategy
- Leverage knowledge and influence
- Swiftly test billion barrel basin potential
- Scaled development options

Hardman deal
- Increases influence and materiality
- 100% and operatorship of Block 2

World-class basin potential
- Eight wells: Eight successes
- First oil & gas flow tested in Uganda
- Highly productive reservoirs, 33º API

Challenges
- Landlocked (1,300km from ocean)
- Establish reserves threshold for export
- Balancing long & short term goals
Lake Albert Rift

- Onshore targets (2008-09)
- Oil seeps
- Ngassa
- Kaiso-Tonya Discoveries
- Kingfisher
- Alluvial Fan
- Low sinuosity channels
- Rift Scarp
- Semiliki Delta
Uganda - Preparing for commerciality in Block 2 (100%)

Kaiso-Tonya area
- 3D seismic – expect complete end Nov 2007
- Nzizi-2 & Mputa-3 drilled, Mputa-4 drilling
- Early production sanction expected in Q4 2007
- First oil targeted for 2009

Butiaba area
- 2D seismic near completion, structures identified
- Light rig tender ongoing
- 3+ exploration wells being prepared for 2008

Exploration of large lake structures
- Significantly de-risked by Kingfisher-1
- Rig contracted to drill Ngassa-1 and Kingfisher-2
- Ngassa-1 expected to spud in October 2007
- Lake drilling solution for 2008 being evaluated
Uganda – Extending success into Blocks 1 & 3A (50%)

**Block 1**
- Cooperation with Tullow operated seismic
- 2D seismic ongoing, structures identified
- Light rig tender ongoing
- 1-2 exploration wells being prepared for 2008

**Block 3A**
- 3D seismic acquired over Kingfisher-1 discovery
- Processing started and 3D interpretation planned
- Kingfisher-2 expected to spud in Q1 2008
- Pelican planned for H2 2008
Building blocks for threshold export volume
Lake Albert Rift Basin Lead & Prospect Funnel

- Emerging Wave (09)
  - Upside plays
  - Offshore follow-up
  - DRC
  - 2D Seismic

- Next Wave (2H 08)
  - Butiaba - Paraa leads
  - Offshore leads
  - 2D Seismic

- Current Wave (1H 08)
  - Butiaba - Paraa prospects
  - Waki-up-dip

Drilling

Appraisal
  - Mputa
  - Nzizi
  - Kingfisher
  - Waraga
  - Kaiso-T 3D
  - KingFisher 3D
  - 4D Modelling

100-250 mmbo (pre-3D)
Building blocks for threshold export volume

- Kaiso Tonya (Waraga / MPuta / Nzizi)
- Butiaba-Paraa (another Kaiso-Tonya? Waki-up-dip / Songo)
- Nearshore material prospects (Kingfisher / Ngassa)
- Lake prospects (Pelican / Ntera)
Kaiso Tonya geological models – 200 MMbo upside potential

Increasing understanding through appraisal
- Reservoir: distribution and quality
- Net Pay: upside in thin beds and weathered basement
- Column Height: Definition of hydrocarbon contacts
- 3D expected to firm up models

Pre-appraisal model (35+ MMbo)
- More isolated volumes
  - No alluvial fans
  - Isolated channels
  - Shoreline deposits
- More wells required to develop field

Possible alternative model (100+ MMbo)
- More connected volumes
  - Alluvial fans
  - Channels extend to lakeshore
  - No shoreline deposits
- Wells in good communication
Building blocks for threshold export volume

- **Kaiso Tonya (Waraga / MPuta / Nzizi)**
- **Butiaba-Paraa (another Kaiso-Tonya? Waki-up-dip / Songo)**
- **Nearshore material prospects (Kingfisher / Ngassa)**
- **Lake prospects (Pelican / Ntera)**
• Residual gravity anomalies reveal several structures

• Structures have been confirmed by seismic data and will be tested by exploration drilling

• Compares well with Kaiso-Tonya and Sudan where major oil fields coincide with gravity highs

Residual gravity anomaly map of EA2, showing distribution of gravity highs oil seepages and well locations
Butiaba: further upside potential in Block 2

Building 2008 Programme

- Waki-1 (1938)
  - Up-dip potential
- Block-1 & 2 Synergies
  - Coordinated seismic & drilling
  - Rig tender closing
- Onshore & Nearshore
  - Accessible prospects
  - Benign terrain

Another Kaiso-Tonya?
Tullow Interest – 100%
Butiaba: Waki up-dip

Waki-2

Waki

Amplitude anomaly

Waki-2 >300m vertically up dip

1173m Sand found with oil – no test

TD at 1232m in basement

2km

TD at 1232m in basement

1173m Sand found with oil – no test

Waki-2 >300m vertically up dip

Amplitude anomaly

Waki

Butiaba: Waki up-dip
Butiaba: Multiple structural traps along basin boundary fault
Building blocks for threshold export volume

- Kaiso Tonya (Waraga / MPuta / Nzizi)
- Butiaba-Paraa (another Kaiso-Tonya? Waki-up-dip / Songo)
- Nearshore material prospects (Kingfisher / Ngassa)
- Lake prospects (Pelican / Ntera)
2007 – 2008 Nearshore Programme

- Nabors 221 Rig
  - On-site for October spud
  - Ngassa-1 90 day well
  - Contingent testing

- Ngassa risk reduction
  - Nzizi-2 gas
  - Mputa-3 sands
  - Kingfisher reservoirs / seals

- First step towards realizing potential of Lake Albert prospects
  - Lake-bed coring initiated for rig tendering
  - Drilling H2 2008
Kingfisher Discovery, Lake Albert Rift

- Top Nyaburogo
- Top Oluka
- Top Kakara
- Top Kisegi
- Top Nyabusosi
- Top M’Puta EQ
- Base Kakara
- Base Miocene
- KF-1
  - Primary objective
  - Secondary objective
- KF-1ST
Ngassa-A Well – Spud October 2007

Good shallow closure
Possible oil shows

Penetrates secondary target

Penetrates high amplitude section

Penetrates the primary target

EXPECTED LITHOLOGIES

Ngassa-A Well – Spud October 2007
Building blocks for threshold export volume

- Kaiso Tonya (Waraga / MPuta / Nzizi)
- Butiaba-Paraa (another Kaiso-Tonya? Waki-up-dip / Songo)
- Nearshore material prospects (Kingfisher / Ngassa)
- Lake prospects (Pelican / Ntera)
Ngassa – Nose extends from nearshore to offshore

Ngassa – follow-on target – amplitude supported

Ngassa nose currently being drilled

Seismic Line shown next

Ngassa downthrown Play (Kingfisher analogue)
Ngasssa – follow on potential offshore

Amplitude support for presence of hydrocarbons in Lake Albert
Ntera offshore prospect Block 2

Closure at multiple stratigraphic horizons
Exploration Summary
Strategy

- Establish working petroleum system in frontier basin and at low cost
  - Integrate a minimal set of gravity, geological and 2D seismic surveys
  - Drill shallow wells at Waraga and MPuta
- Extend lead inventory through modern gravity and 2D seismic surveys
- Map and mature leads into prospects and procure appropriate rigs
- Drill out prospect inventory to establish pipeline threshold volumes
- Appraise discoveries through 3D seismic and appraisal drilling
- High resolution subsurface modelling
- Early production system and reservoir connectivity testing
Resource volumes

- Current assessment of basin volumes discovered: 100-250 mmbo

- Building blocks have potential to reach pipeline threshold volume
  - Kaiso Tonya (Waraga / MPuta / Nzizi)
    - Alternative geological model 100 mmbo (200 mmbo P10 including speculative upside plays)
  - Butiaba-Paraa (Waki-up-dip / Songo)
    - Another Kaiso-Tonya?
  - Nearshore material prospects (Kingfisher / Ngassa)
    - Each multi-100s mmbo prospects
  - Lake prospects (Pelican / Ntera)
  - Currently 25 undrilled leads and prospects

- Basin has billion barrel potential – 80% unexplored