Offshore East Africa—where is all the oil?

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Introduction

- Offshore East Africa, only gas has been found in commercial volumes
- Oil discoveries onshore Uganda, Kenya, Mozambique and Madagascar – along with numerous seeps along the coast – encourage the continued pursuit of the elusive offshore oil.
History of Exploration

- **1950-1964** Majors perform geological studies and the petroleum system is proven.
- **1980-1990** Increased drilling period. ENI discover Mnazi Bay gas field.
- **1990-2000** Exploration efforts wane due to prediction of gas-prone source rocks.
- **2000-2009** First gas produced Songo Songo and Mnazi Bay.
- **2009-2014** Renewed exploration with intensive drilling campaigns resulting in multiple multi-TCF gas discoveries in Mozambique and Tanzania.

**Sources:** TPDC, INP, Wenworth Resources, Orca Exploration
Postulated Source Rocks

**Paleogene-Neogene:**
Restricted to localised pro-delta environments and rarely attained sufficient thermal maturation.

**Post mid-Jurassic – Cretaceous:**
Likely to be gas prone due to paucity of oil-prone kerogens at the time.

**Lower-Middle Jurassic:**
Generally deeply buried. Widespread Miocene inversion thought to have flashed much of the oils to gas.

**Triassic:**
Likely to be over-mature.

**Permo-Carboniferous:**
Compositionaly prone to be gas bearing.
Early Jurassic
Transition between Permo-Trias riftting and sea-floor spreading.
Thermal doming between Tanzania and Madagascar

Mid-Late Jurassic
Madagascar begins southerly drift along Davie Fracture Zone.
Source rocks deposited in semi-restricted settings.

Cretaceous
Continued drift of Madagascar.
Major deltas begin to form in coastal basin.
Natural Gas assets in East Africa
Source Intervals

- An Early-Mid Jurassic marine shale is thought to source much of the gas in offshore Tanzania and Mozambique.

- This source rock has not yet been directly sampled.

- Is gas being generated because?
  - The source rock predominantly lies within the gas window.
  - Some areas of this source rock had high gas-prone terrigenous input
Gas Discoveries - Mozambique and Tanzania

- 20-30 TCF discovered offshore Tanzania
- 120-150 TCF discovered offshore Mozambique

Source: PetroView
Ages of Gas Discoveries in Tanzania

- **Pliocene** Carbonate: Ziwani
- **Miocene** Slope Channel: Mkizi (Block 1)
- **Oligocene** Delta: Mnazi Bay, Msimbati
- **Oligocene** Slope Channel: Chaza (Block 1)
- **Paleocene** Slope Channel: Jodari (Block 1), Lavani & Tangawizi (Block 2), Pweza, Chewa & Ngisi (Block 4)
- **Campanian** Slope Channel: Mzia (Block 1), Zafarina (Block 2) and Papa (Block 3)
- **Albian** Delta sands: Ntorya
- **Neocomian** Shoreface sands: Songo Songo

Source: TPDC
Other oil play factors - Crustal Type

• The nature of the crust which underlies the East African margin is subject to current debate.

• Geochemistry of the Grand Comore lavas indicate an oceanic crustal signature to the Comoros islands - a useful Eastward constraint upon the location of the crustal boundary.

• Gravity and magnetics data over the area is also subject to debate, as seafloor topography associated with the Davie fracture zone and Rovuma delta make the interpretation more difficult.

• Attempts have been made to pick a distinct crustal boundary on 2D seismic
Offshore Oil Discoveries?
Kenya - Sunbird-1

- The well was completed in the March 2014.
- Water depth 723m
- ~900m of overlying sediment
- “. . . gross 29m gas column overlying a gross 14m (9.2m net) oil column” in a Miocene Pinnacle Reef.
Kenya – Lamu Basin

- Davie-Walu Ridge
- Tembo trough
- Simba High
• Prognosed Eocene source
• East of the Simba High, Cretaceous age clastic play expected to be sourced by gas mature Jurassic.
Further Lamu Basin oil leads
Offshore oil discoveries?
Mozambique - Ironclad

- Ironclad-1 drilled by Anadarko had oil (and gas) shows in tight Cretaceous deepwater fan sandstones in Area 1 offshore Mozambique. 2010.
Offshore oil discoveries?
Mozambique - Ironclad

- Oil presumably sourced from less deeply buried Jurassic underlying the prospect.
- Cretaceous reservoir of poor quality, unlike the neighbouring Tertiary gas bearing sands

Seismic and Cartoon adapted from Law, C. 2011.
Offshore Kenya

Anadarko Kubwa well in the L-07 Block offshore Kenya, encountered non-commercial oil shows in reservoir-quality sands.

Ophir indicates that satellite slick studies suggest an oil-prone region offshore Kenya.
Conclusions

- Oil in commercial quantities remains elusive offshore East Africa.
- The widespread Jurassic source rocks tend to be in the gas window.
- Less deeply buried Jurassic sources could perhaps exist:
  - Closer to shore,
  - In deeper water where there may be less overburden,
  - In sub-basins with different tectonic history
- Alternative (younger) oil mature source rocks may be developed in restricted sub-basins
- Any detailed source rock information from recent wells is proprietary.
- Recent Tanzania offshore license round had limited appeal (is more gas in deeper water further from the shore attractive?)
- But there were successful bidders. What do they think they know?
- GCA would be pleased to help you in this ongoing pursuit.
Thank you

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