East Africa: What’s left?

A Sub-Surface Perspective

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Presentation Outline

- Introduction and regional setting
- Petroleum Systems
- Onshore
- Deepwater
- Other Areas
- Conclusions
East Africa in context

- East Africa has for many years been the “poor relation” compared to its West and North African cousins.
- Hydrocarbon exploration has been occurring in the region for more than 80 years.
- Only in the last 10 years has the potential for commercial oil and gas been realised.
- This is currently limited to (small-scale) gas production in Mozambique and Tanzania.
- LNG from the recent deep-water discoveries (from 2018?), and the onshore oil discoveries in Uganda and Kenya will change this picture.
- The real question is what is left / what is next?

Source: Purdy, 1989
East Africa – Many possible petroleum systems and play types

- Many petroleum systems have been identified in East Africa ranging in age from the Palaeozoic to the Neogene
- These are developed in a wide range of structural and stratigraphic styles and geographic areas
- Digital Elevation Model (DEM) indicates the (relatively) limited area of the East African Rift System (EARS) (in pale blue)
- Petroleum systems occur outside of the EARS
  - Lamu Basin / Anza Graben (South Sudan extension) (red)
  - Deepwater, extends to Kenya / Somalia
East Africa- Multiple petroleum systems and play types

- Onshore and Offshore – What at the similarities and differences?
- The recent success in the deepwater of Mozambique and Tanzania has little or relation to the onshore geology of the EARS (and vice versa)
- Offshore Gas, Onshore Oil (predominantly)
- BG’s recent Sunbird oil discovery is shallower water is more closely related to the onshore petroleum system than the deepwater. Does this provide hope for an offshore oil play?
- Recent discoveries in the EARS in Uganda and Kenya show similarities and differences – can the results be successfully exported to other Rift Basins where similar reservoirs, but with different timing of rift basin development.
- Does this knowledge and understanding allow the grading / ranking of un(der)explored basins?
- Mesozoic petroleum system in Karoo (continental Africa and Madagascar) and Ogaden Basin – a possible extension of the proved and productive plays of the Arabian Peninsula
## Petroleum Systems

### Onshore
- Karoo system - Madagascar
- Mesozoic
  - Melud / Anza Graben
  - Ogaden Basin
- Tertiary East African Rift System (EARS)
  - Western Branch
  - East Branch

There still remains a lot of uncertainty associated with the development of an effective petroleum system in other basins within the EARS

### Offshore
- Karoo type
- Cretaceous / Songo Songo
- Tertiary deepwater foldbelts (gas-prone?)
- What other plays are yet to be found? A key driver / change will occur when a significant offshore oil discovery is made in East Africa
Exploration drilling is concentrated to the “sweet-spots”

- Lots of wells have been drilled in the area. However, the geographic distribution is limited.
- Lots of wells in “sweet-spots”
- Large areas are lightly explored and essentially undrilled (<10 wells drilled in the deepwater outside of the “sweetspot”)
- Does this distribution reflect the true prospectivity of the area or is it driven by data limitations, lack of knowledge or courage on the part of the explorers?
- Of the prospective sedimentary basins most acreage has recently been licenced
Host Governments are keen to build on the recent success by licencing additional blocks.

RSA, Somalia and Madagascar have rounds scheduled.

However, recent Tanzanian licence round had limited interest from the industry.

Expand on recent success.

Re-visit other area.

Both are not risk free!

Many of these issues are not subsurface related, however, they do have a major impact on exploration activity and therefore on increasing subsurface understanding.
ONSHORE
Onshore Exploration

- Large area available for exploration with sparse datasets (wells and seismic data)
- Remote sensing (e.g. gravity and magnetic) data has been key to defining basins and potentially prospective area
- Interpretation requires “ground truthing” and subsequent seismic and drilling before a petroleum system can be demonstrated
- This can take a long time to achieve
- Use legacy data where available (including other industries data e.g. mining) to assist in evaluation
Ethiopia – Geological Map

- Ogaden Basin Mesozoic Play
  - Proven potential
  - Hilal and Calub discoveries
  - Will these be developed?

- Oil / Gas / Condensate
  - El Kuran discovery
    - shallow oil
    - deeper gas
    - Recent drilling results are mixed
  - Are these results sufficiently encouraging to allow further exploration?

Source: Ethiopian Ministry of Mines, energy and Water Resources
Ethiopia – Ogaden Basin cross-section
Multiple plays in carbonate and clastics

Source: Lundin Petroleum
Deepwater Exploration – Many Players

- Acreage along the coast extending into ultra-deep water licensed. Some recent relinquishments following initial disappointment
- Success in Mozambique and Tanzania
- Limited exploration drilling elsewhere, and limited success
- Apache have withdrawn following “gas-discovery” in Kenya L-8
- New acreage has been taken in Somalia and Comoros
- Gas has been the dominant hydrocarbon
- Explorers still hoping for the “Big Oil” discovery – still a lot of remaining uncertainty

Source: Petroview Sub Saharan Africa - Nov. 2014
South clastic dominated, north carbonate dominated
Clastic input controlled by palaeo-rivers associated with PanAfrica lineaments?
Does this provide a predictive model for reservoir presence
Deepwater Mozambique
Barquentine / Windjammer discoveries

- Provides evidence for sandstone reservoirs at several levels in a variety of traps
- Appears to confirm the reservoir presence predicted in the Chronostratigraphic chart (for the south)
Offshore Somalia
Continuation of Deepwater fold-thrust belt

- Seismic data indicates the potential for deepwater foldbelt and also stratigraphic trapping
- Remote to well data – will reservoirs be developed?

Source: Soma Oil & Gas, 2014
Offshore Kenya
Continuation of Deepwater fold-thrust belt

- Results confirm presence of sandstone reservoirs offshore Kenya – also described in Pomboo-1 well
- Suggests that the Chronostratigraphic model is pessimistic in the north (wrt sandstones)
- Do the results indicate that the palaeo-Lamu river was the source of these sediments?
Juan de Nova and Madagascar

- 3D seismic has been acquired
- Interpretation underway
- Will this provide a play extension to the deepwater gas discoveries, or will it be a “new” petroleum system
- Probably not this simple, likely that play elements will be different.
- Is this a real opportunity or the explorers eternal “hope over expectation”, only time will tell!

Source: Sterling Energy
Sifika Prospect Madagascar

- ExxonMobil farmed-in and took operatorship
- Large trap – play opener offshore Madagascar
- Does onshore knowledge provide useful information to de-risk the opportunity?

Source: Sterling Energy
Conclusions

- East Africa contains multiple potential petroleum systems
- Recent exploration success has confirmed two very different petroleum systems
- Regional geological knowledge suggests that these systems may extend beyond the current proved areas
- Other petroleum systems have been demonstrated, but have yet to be shown to be potentially commercial
- Will future exploration focus on the “proved” petroleum systems or move on to other yet to be found systems?
- The current oil price may result in a further reduction in exploration activity in the region and less appetite for the higher risk opportunities
Experts in East Africa

Gaffney, Cline & Associates