

Opening New Oil Basins: A Pattern of Discovery*

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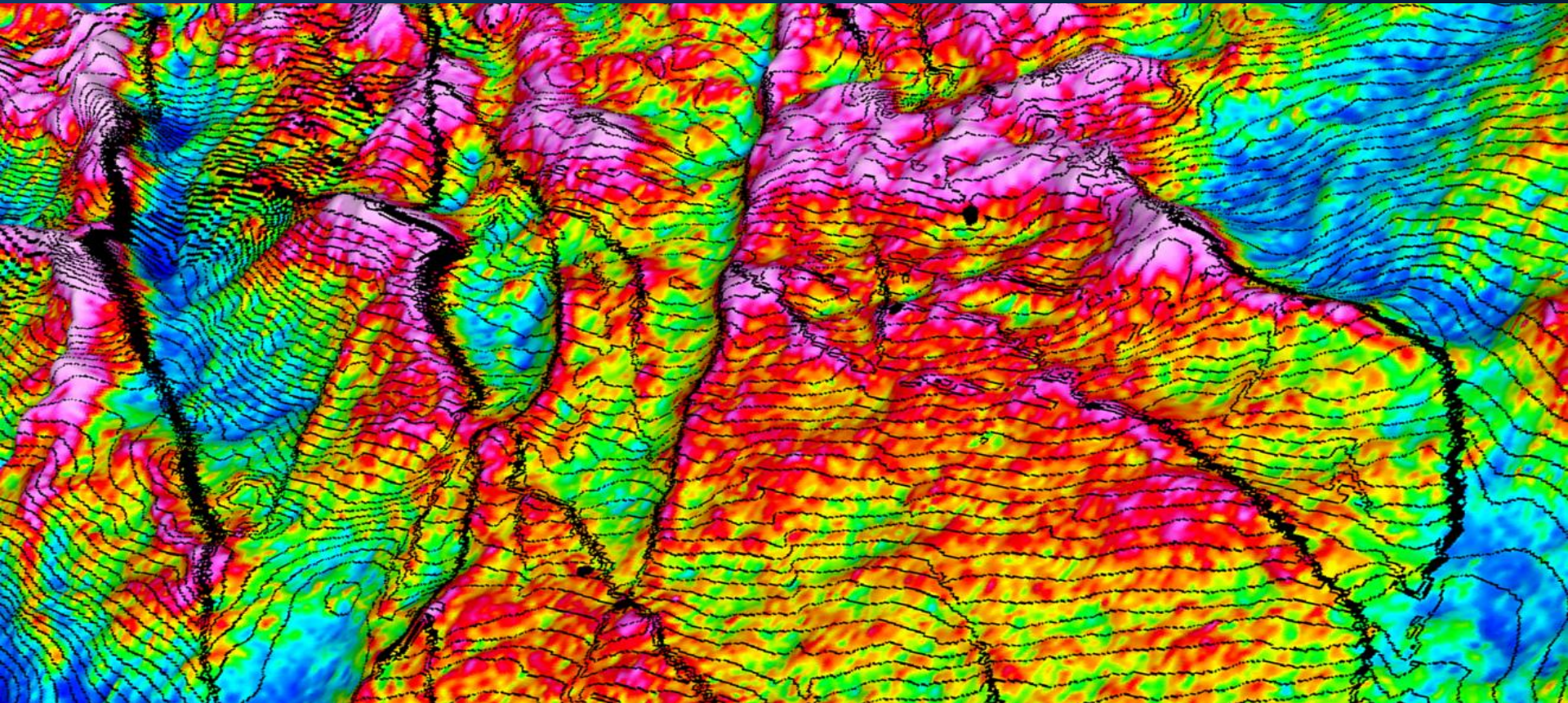
Abstract

I discuss our team's story on opening new oil basins and show there is a pattern of discovery. Tullow Oil is focused on finding oil and then selling it in the ground or through the pipe. We are focused on low-cost of supply, light oil which flows naturally. We are conventional oil finders and our exploration covers two continents – Africa and South America. Africa is the continent in which Tullow Oil began doing business, and where we see considerable future exploration potential. South America presents us with exciting new opportunities and a chance to replicate the exploration success we have had in Africa. Our “off-limits” exploration filters help us focus on high-margin light oil in onshore rifts in East Africa, simple offshore settings on the African and South America continental margins and in our production heartlands of West Africa, particularly in Ghana.

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Opening New Oil Basins: A Pattern of Discovery

Angus McCoss, Exploration Director, Tullow Oil plc



Oil finding focus

18

Countries

102

Licences

147

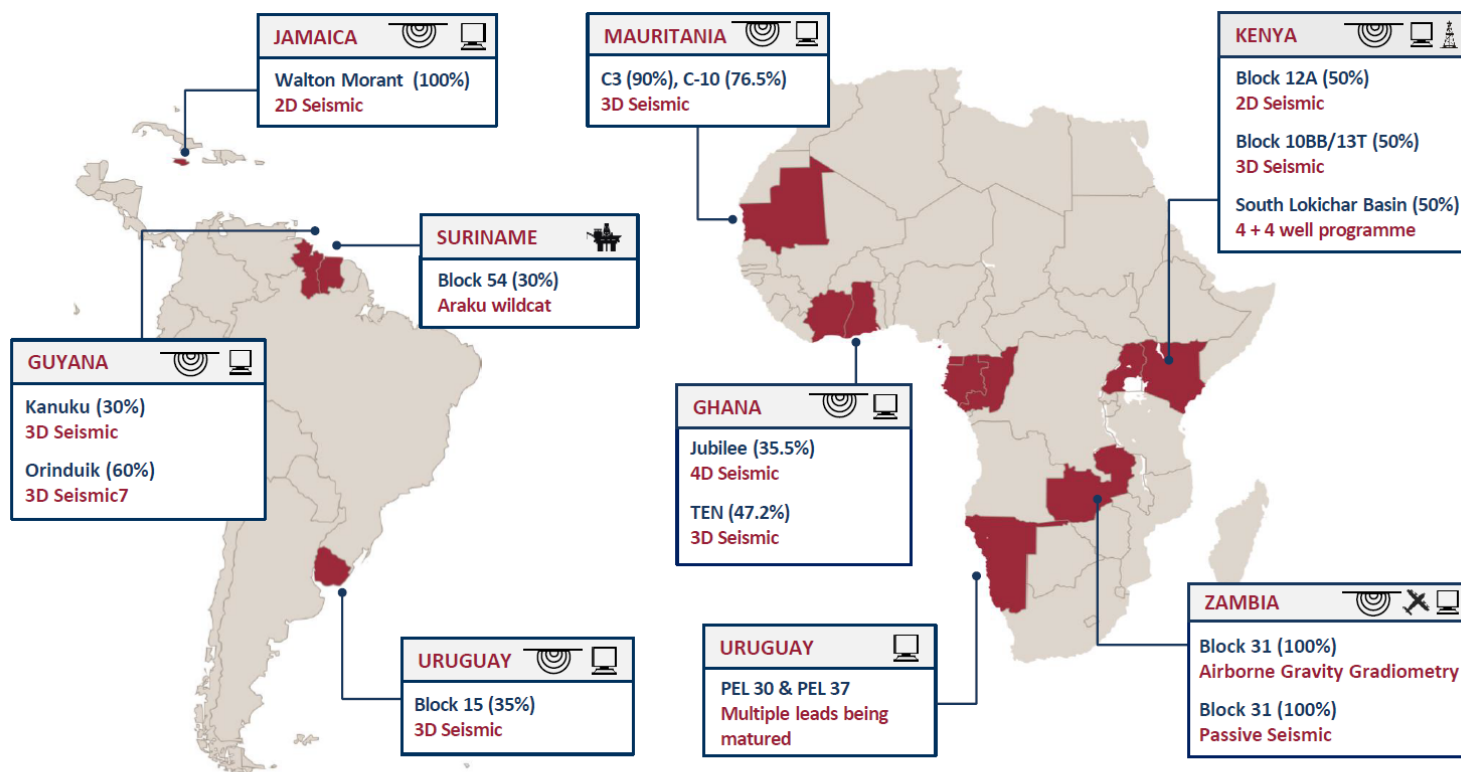
Geoscientists

1.2Bboe

Reserves & Resources

78-85k

bopd YE est 2017



SEISMIC



Acquisition



Processing / Re-processing



Airborne Surveys

DRILLING



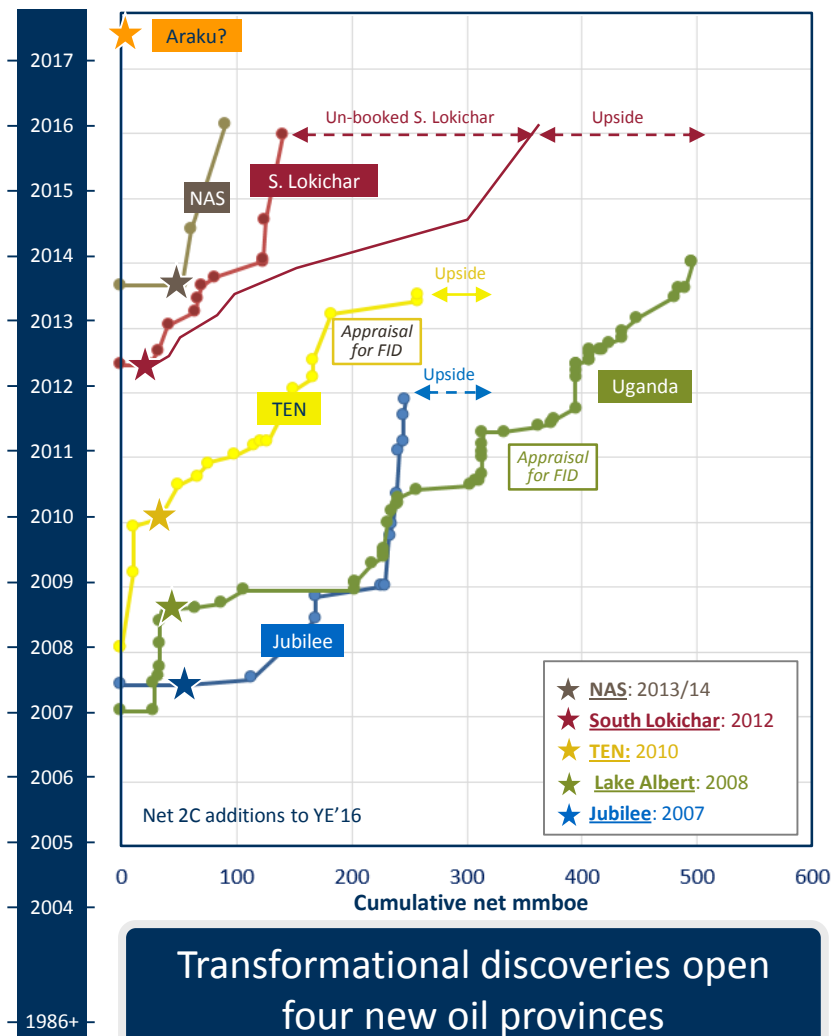
Offshore



Onshore Firm

“Chronostratigraphy” of Tullow Oil

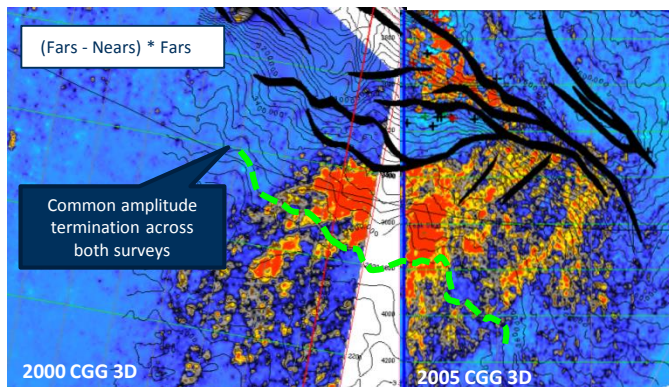
Building on Success	Farm down in Uganda Tullow exits Norway TEN first oil	○ Araku? ● Erut, South Lokichar ● NCS appraisal
		● South Lokichar discoveries
	Awarded Suriname Block 54	● NAS
	Uganda farm-down	● Ngamia, Kenya
	Listing in Ghana	● Zaedyus
	Jubilee first oil	● Tweneboa, Enyenra, Ntomme
Foundational Discoveries	Major E&A successes in Uganda and Ghana	● 5 oil discoveries Lake Albert ● Jubilee
Early Exploration	Hardman – French Guiana	● Discoveries in Gabon, Mauritania & North Sea
	Energy Africa - Uganda, Gabon, EG, Namibia, Congo	
Base	New licences in Asia, Europe & Africa First production, listing in London & Dublin	● Sara gas discovery, Pakistan



Jubilee: Progressive exploration & development in Ghana

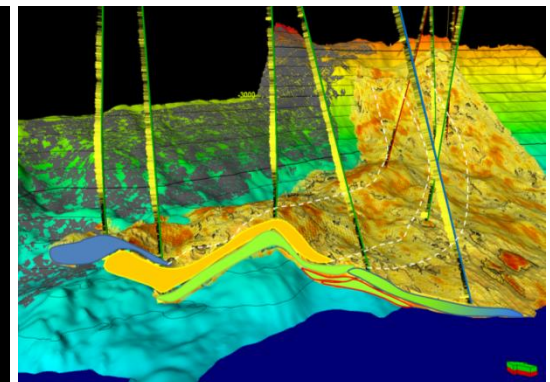
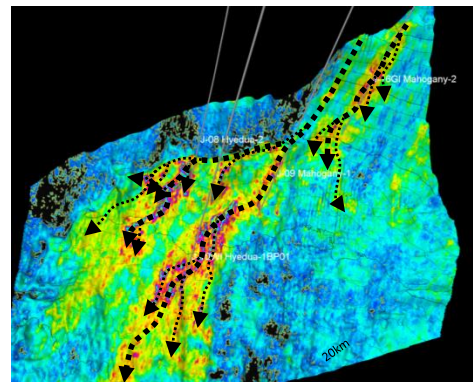
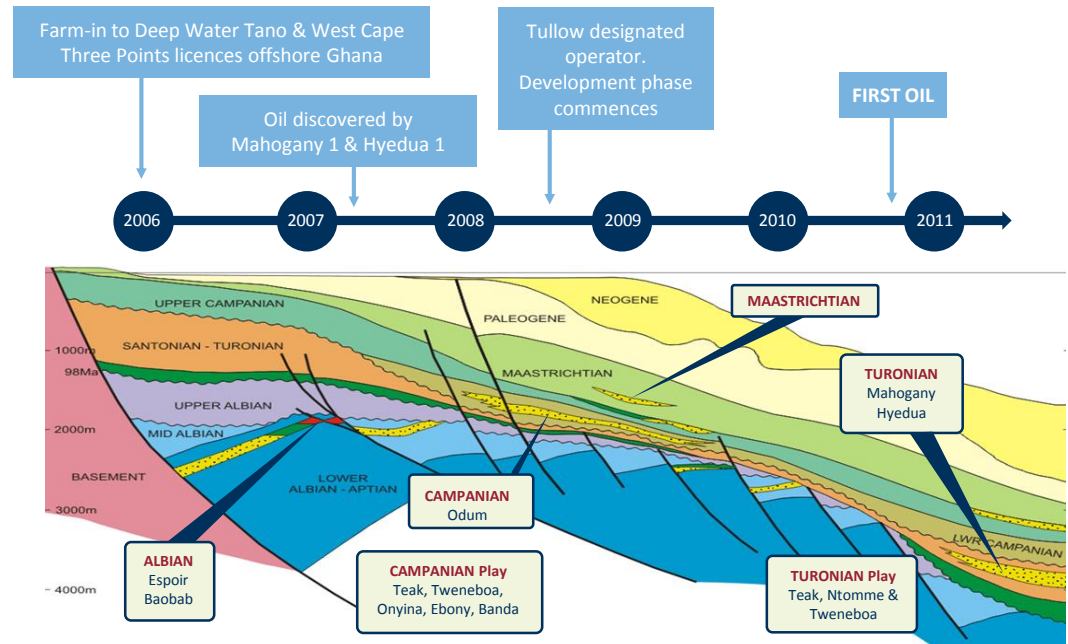
Frontier exploration de-risked

- Proven petroleum system on shelf
- Class 2 AVO fits structure, albeit on two vintage 3D surveys with “risky” gap
- Geological Goldilocks zone 40% N/G

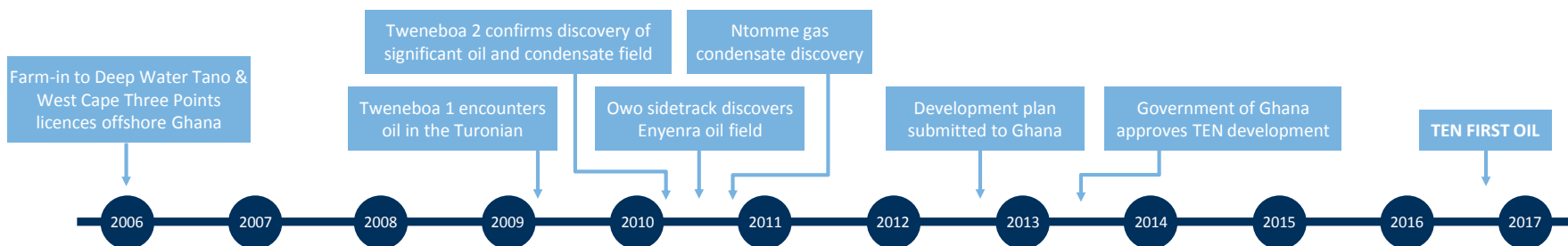


Jubilee present & future

- 4D dual-azimuth seismic complete
- Dynamic sub-surface data integration
- Iterative updates of reservoir model

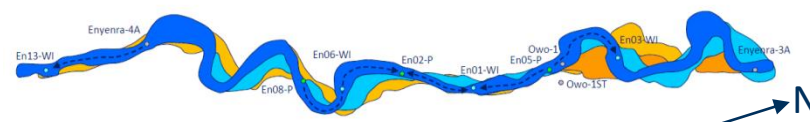
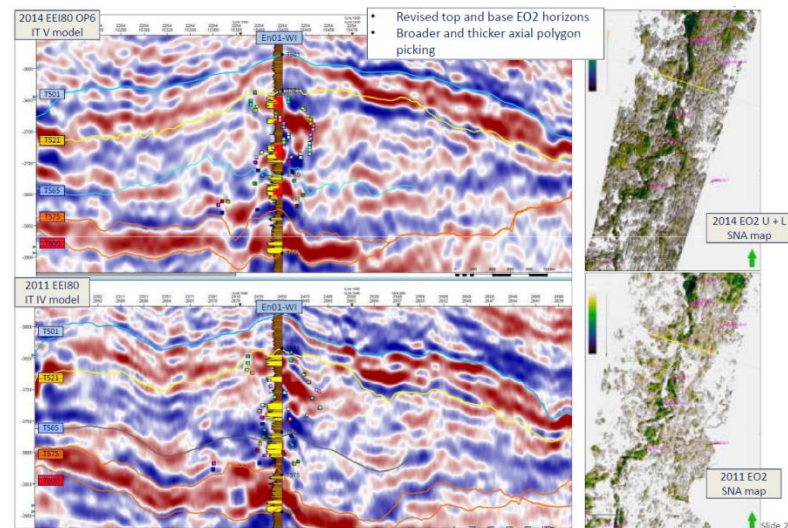
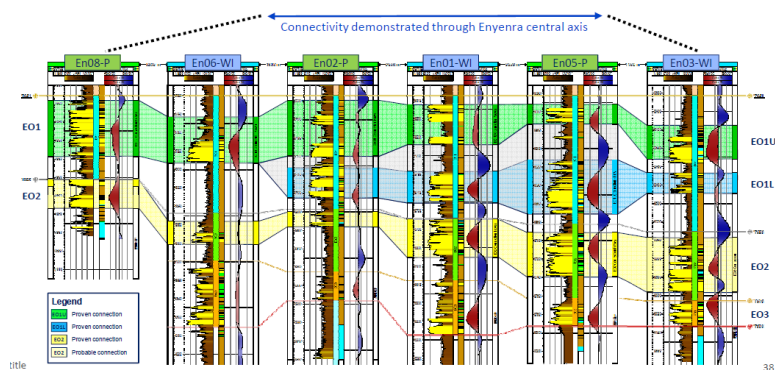


TEN: Extending the Turonian play west of Jubilee



Tweneboa-Enyenra-Ntomme

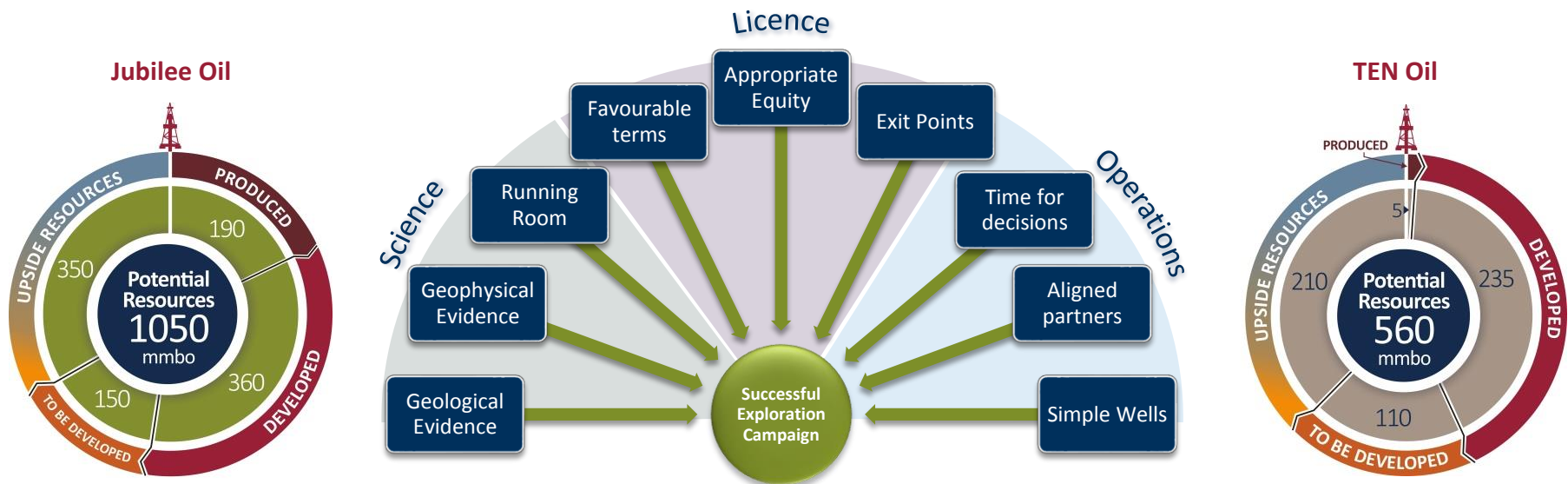
- High quality 3D seismic proved essential
- Extended Elastic Impedance “patterns” learned from Jubilee
- However, thinner reservoirs complicated the EEI “pattern”
- Bold 5 km outstep appraisal wells - could have been 15 km !



Pattern of exploration success in Tano Basin, Ghana

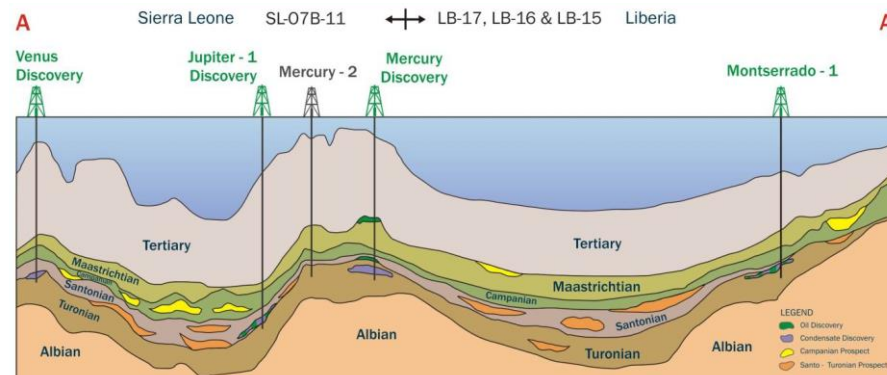
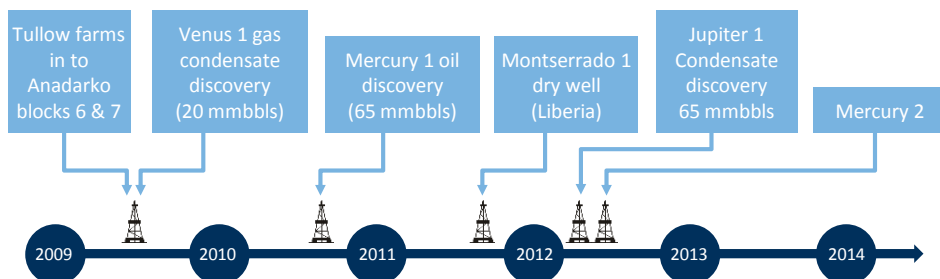
Insights & Lessons

- Paradigms challenged - industry over-focused on Cenozoic turbidites
- Proven working petroleum system reduces exploration risk when opening a basin
- Understand & adapt to limitations of geophysical methods
- Good quality seismic data during the exploration phase enhances impact & efficiency
- Aligned partners enabled acceleration of Jubilee & T.E.N. exploration to production (in 40 months)



Quick to “follow golden threads” – prioritized for high-return investment

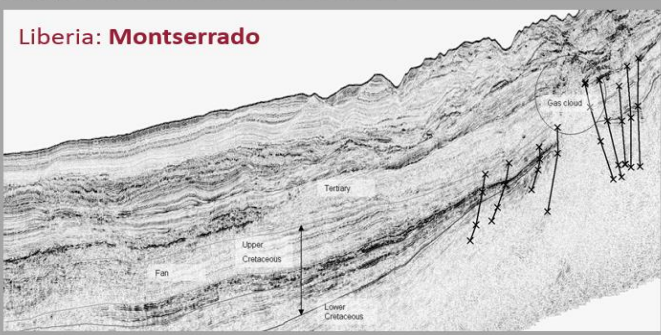
Hunting for another Jubilee along the African margin



Ghana: Jubilee



Liberia: Montserrado



Geophysical analogues - over-emphasized

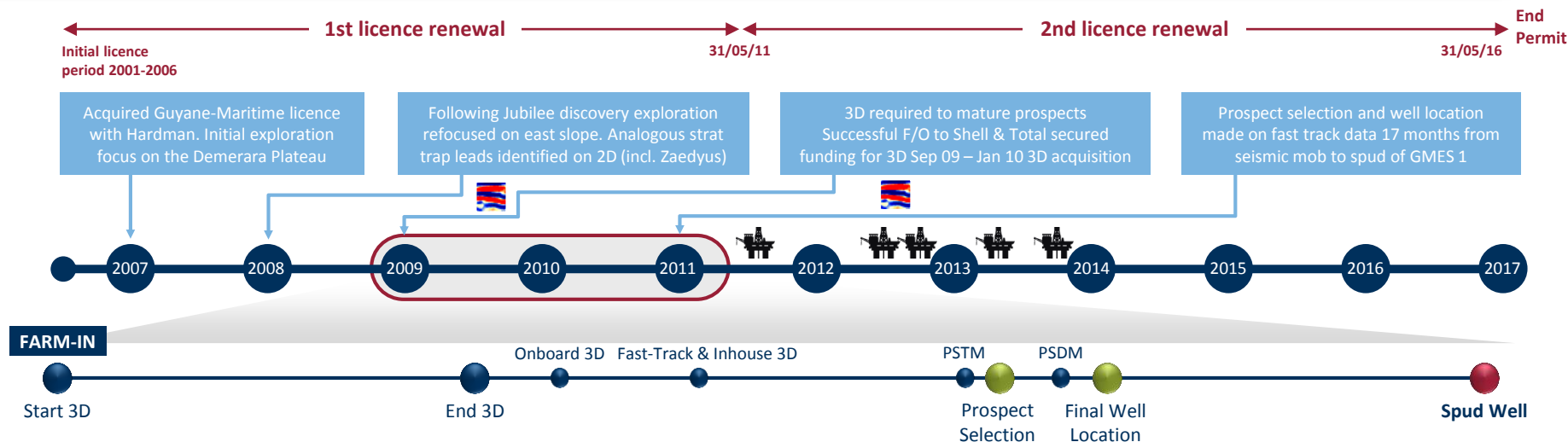
- High profile industry campaign in Cote d'Ivoire, Sierra Leone & Liberia
- Strikingly similar seismic, supported by AVO and EEI
- Paon, Venus, Mercury & Jupiter discoveries - up to 31 m net pay

Geological Goldilocks zone - too shaley

- Reservoir quality and N/G quickly identified as issues
- Limited well control, stratigraphic knowledge incomplete
- Under-appreciation of erosion impact - trap breach

Over-confidence in stratigraphic traps

French Guiana: Jubilee twin across the Atlantic?

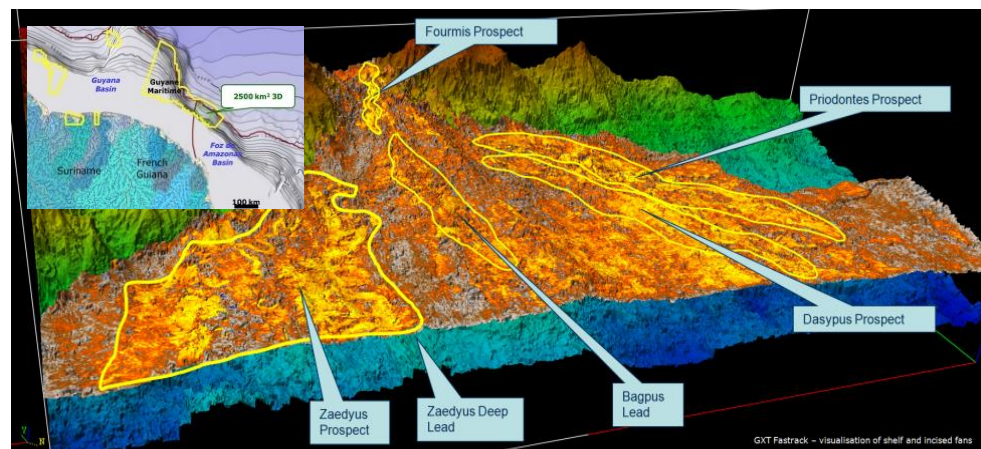


Giant Cingulata Turbidite Fan Complex

- EEI predicts sand presence but not quality
- Class 1 AVO - limited fluid response
- Tullow's most complex deep-water well

Geological Goldilocks zone - too sandy

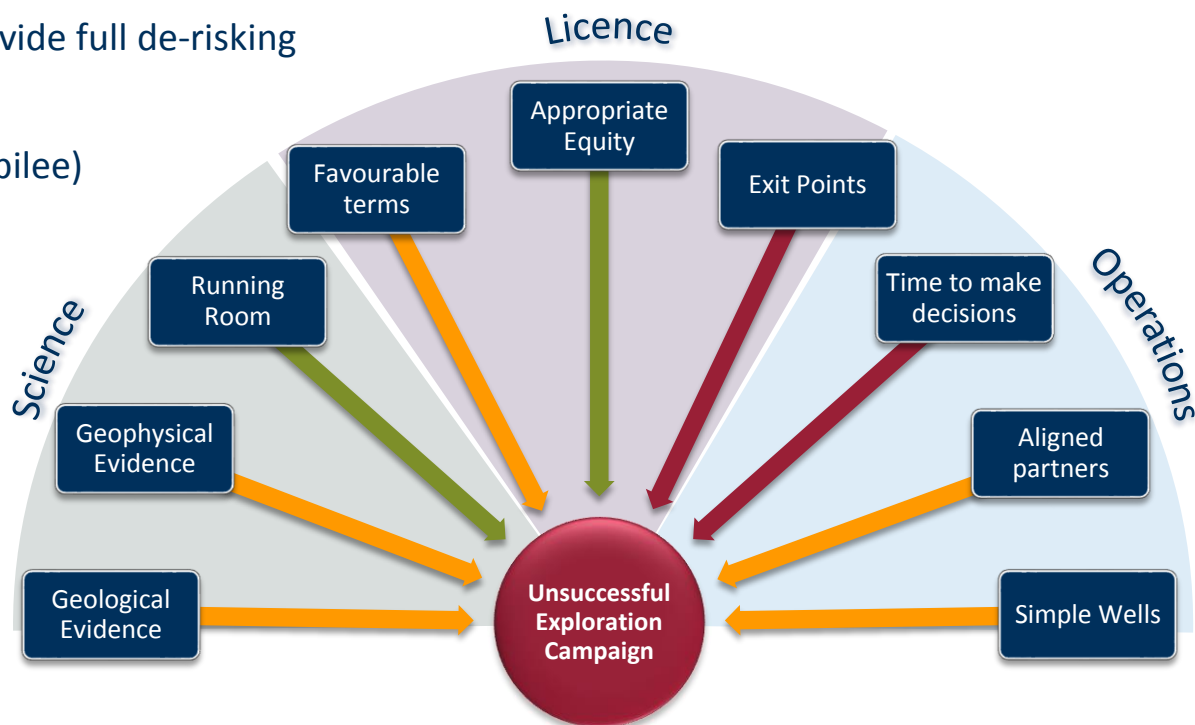
- Maastrichtian & Santonian 72m net oil pay discovered below thick mudstone seals
- Hasty appraisal: back-to-back rig-driven programme



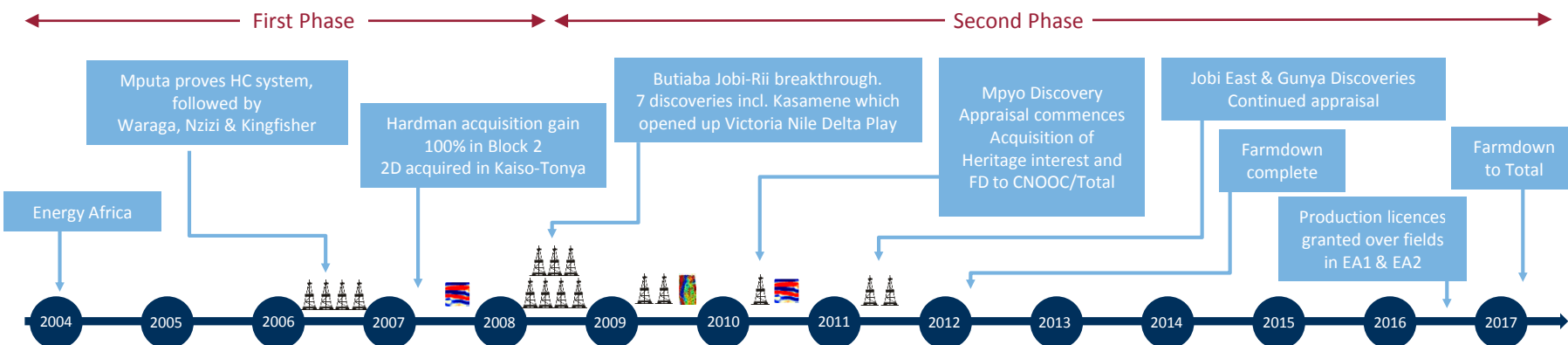
Tried to extend the Jubilee play “pattern” - but unsuccessful

Insights & Lessons

- Wells drilled during significant sector cost escalation – minimum commercial field size trebled
- Compressed timelines due to licence deadlines added significant pressures
- Need to properly understand consequences of data quality
- Uncalibrated drilling complexity in frontier exploration
- Geophysics alone does not provide full de-risking
- Holistic play analysis essential
- Goldilocks zone = 40% N/G (Jubilee)



Uganda: finding oil from first principles



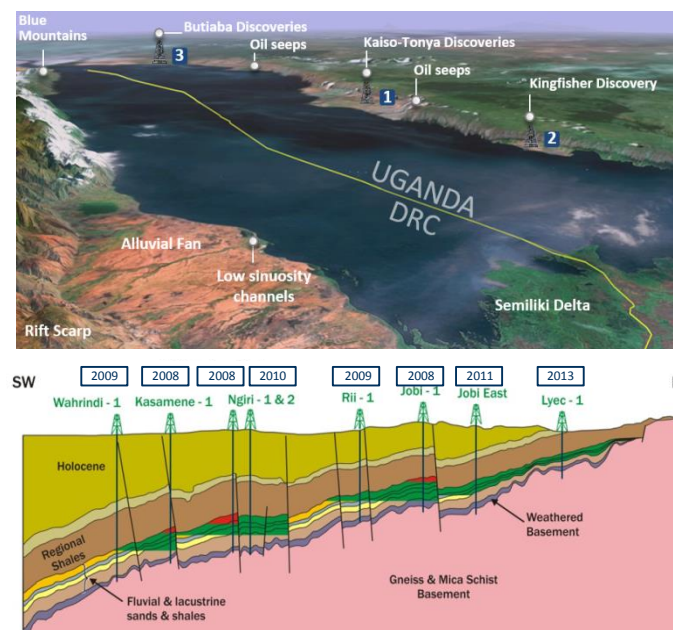
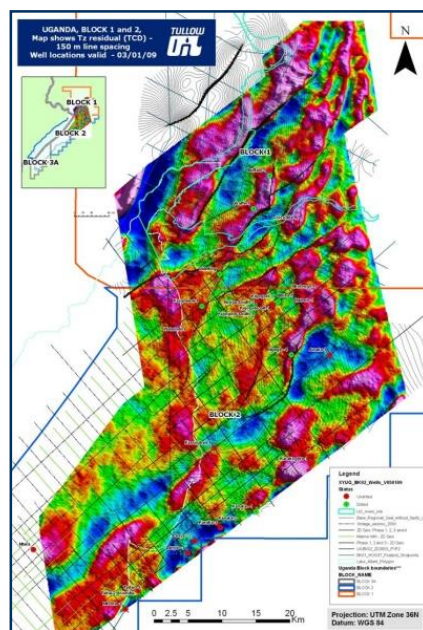
Attracted to oil seeps

- First wildcats drilled on 2D seismic, guided by geological fieldwork
- Darcy permeability reservoirs identified

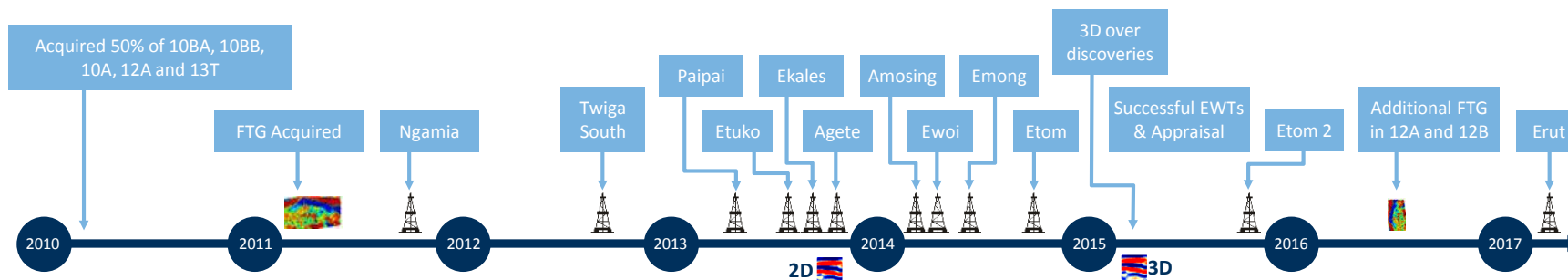
Strategic geophysics & wildcatting

- 2007 basin-wide 2D seismic acquisition
- Kasamene discovery opens Victoria Nile play
- 2009 FTG acquired: pseudo-3D survey
- 3D seismic acquired 2011 for appraisal phase

Wells tested at 1,100 -14,000 bopd
32° API Oil



Kenya exploration campaign shaped by Ugandan “patterns”

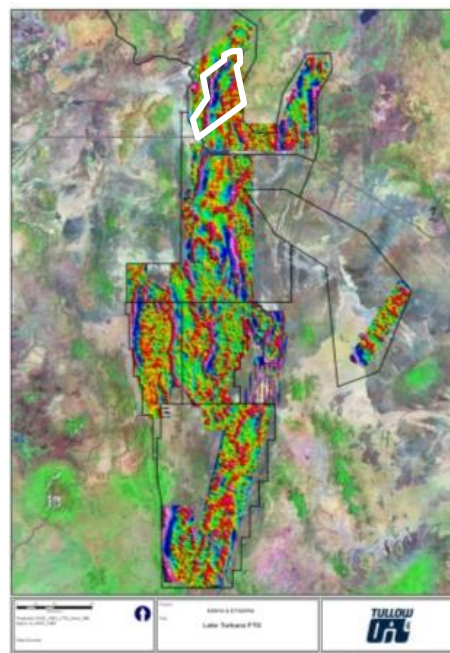


Regional approach to onshore Africa exploration

- Loperot-1 legacy well proved working petroleum system
- Legacy 2D plus Tullow FTG generates significant inventory
- Ngamia-1 opens basin & 2D seismic firms up next prospects
- Several other basins tested with wildcats

South Lokichar Basin exploration & appraisal

- Early 3D seismic for appraisal & development
- 20 untested prospects in 1Bbo upside potential
- 2017 E&A wells drive basin towards 2018 FID

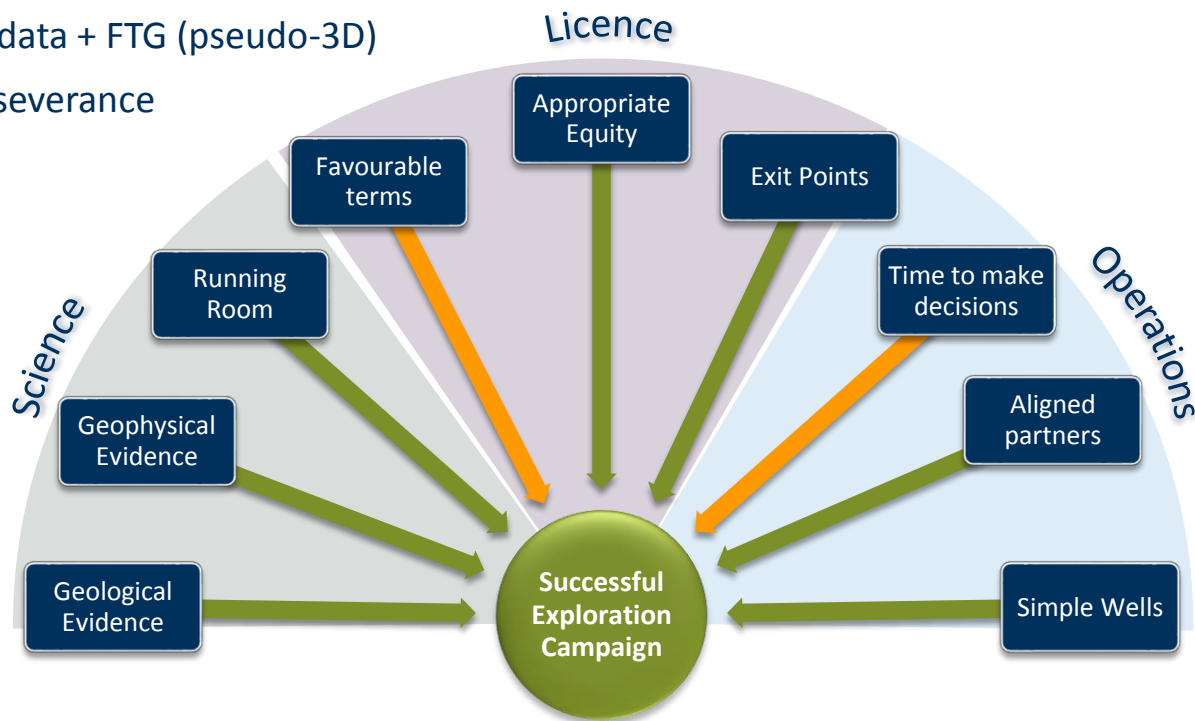


World class source rock: 10/12 success ratio

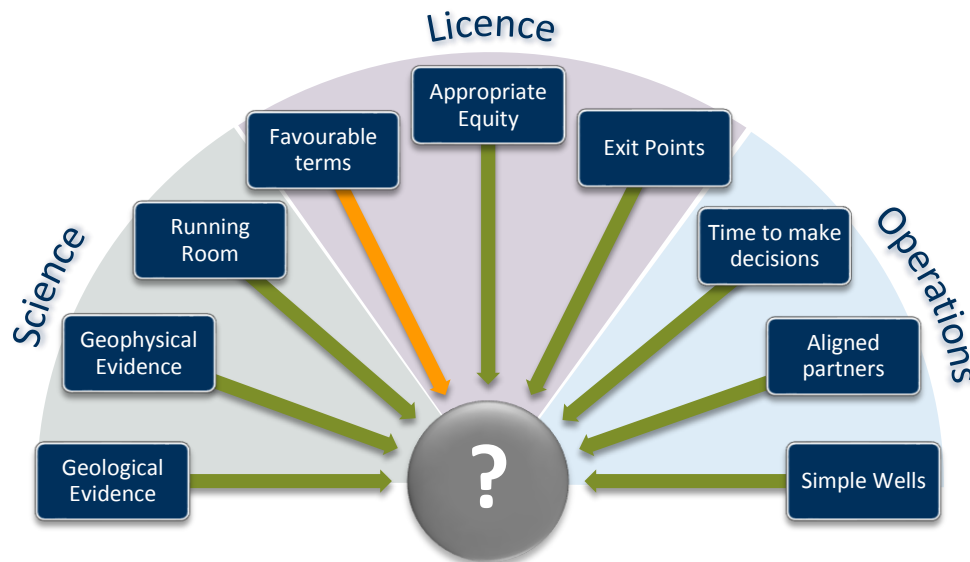
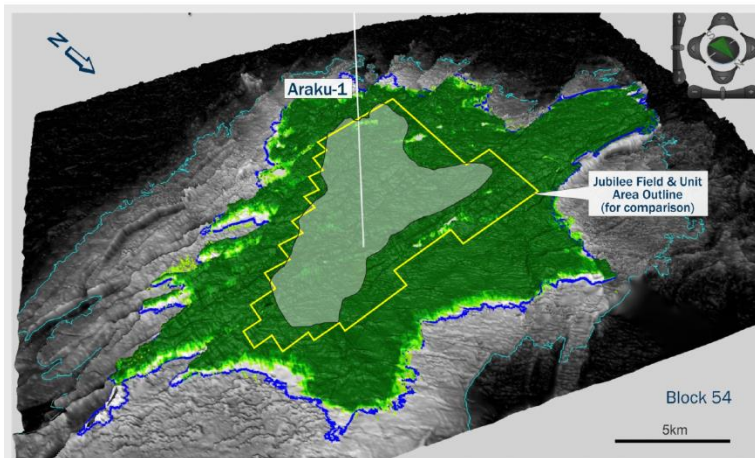
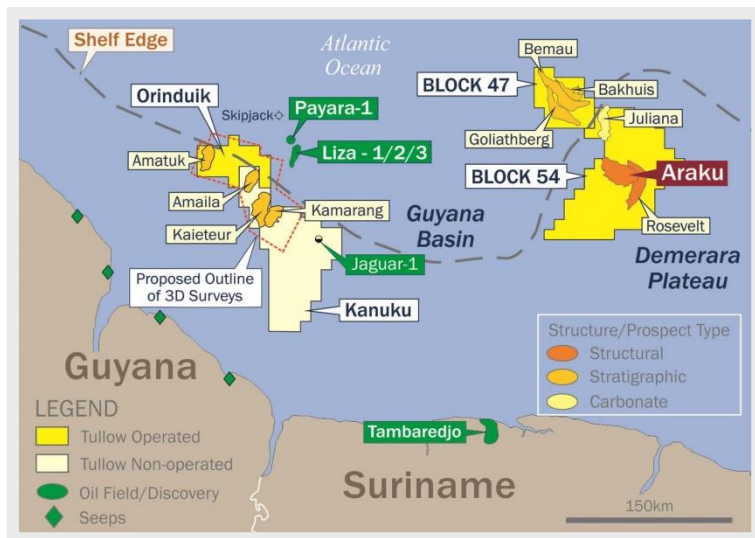
Pattern of exploration success in East African Rift Basins

Insights & Lessons

- Paradigms challenged - industry over-focused on dormant rifts
- First mover advantage, ~100,000 sq km acreage position
- World class source rocks in oil windows - seeps indicated active petroleum province
- FTG reduced our footprint, time & cost
- Wildcats on sparse 2D seismic data + FTG (pseudo-3D)
- Imagination, geoscience & perseverance
- Prioritized for value build



Araku: Testing new patterns in Guyana-Suriname basin



High-impact, high-reward prospect from portfolio refocus

- AVO supported, multiple flat spots, 4-way closure
- Simple well design, moderate water depths
- 500mmbo, high impact, follow on potential
- De-risked by Liza-1 oil discovery in the basin

Material low-cost new play in de-risked oil province