

Are Stratigraphic Traps More Risky?*

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Search and Discovery Article #70310 (2017)**

Posted December 18, 2017

*Adapted from oral presentation given at AAPG/SEG 2017 International Conference and Exhibition, London, England, October 15-18, 2017

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Abstract

Historically, stratigraphic traps have been perceived to be more risky than structural traps. This study analyses 271 exploration wells worldwide that targeted stratigraphic traps in clastic reservoirs since 2008, to investigate if this perception is justified. Over the study period, only 15% of exploration wells globally have targeted stratigraphic traps. They had an average Technical Success Rate (TSR) of 49%, comparable to other trap types, and an average Commercial Success Rate (CSR) of 26%, which was 10 percentage points lower than other trap types on average.

Most stratigraphic traps tested during 2008-1H2016 were located in passive margins targeting Cretaceous and Tertiary turbidite complexes, with half of them located in deepwater (>500m) areas. Performance in stratigraphic traps needs to be reviewed on a basin and analogue basis to remove other play risks that have a greater impact on performance than the trap type itself.

The Cretaceous turbidite play along the Africa Transform Margin has been one focus area, covering basins from Sierra Leone to Benin. Whilst stratigraphic traps along the margin have had a TSR of 67%, only the Tano Basin has delivered commercial volumes so far. Well failure and success analysis show that the non-commercial volumes associated with discoveries outside of the Tano derive largely from the basin configurations, influencing turbidite deposition, and resulting in a lack of charge focus.

In many cases, stratigraphic traps have taken the blame, but the causes for low CSRs are more profound and significant for the exploration potential of the whole margin. In areas where turbidite systems can be connected and hydrocarbon migration focal points exist, there is a greater chance of commercial success. Unfortunately, seismic attributes, even when effective, do not appear to de-risk reservoir connectivity.

The dataset reveals that stratigraphic traps delivered larger discovery sizes for oil than other trap types – driven by the Tano Basin discoveries and recent discoveries in Guyana. Stratigraphic traps had low finding costs overall at c.\$1/boe. Success rates and finding costs can match or better structural traps in some areas, especially for gas plays.

Stratigraphic traps do not appear to be inherently riskier, although success in these plays relies on using the right geoscience tools and ensuring integration of the trap element into the entire petroleum systems analysis.

Reference Cited

Mathieu, C., 2015, Moray Firth – Central North Sea Post Well analysis: Oil and Gas Authority, Aberdeen, United Kingdom, 208 p.

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- Definitions
- Global performance of stratigraphic traps
- Late Cretaceous turbidite play of Africa Transform Margin
- North Sea and Carnarvon mature basins
- Conclusions

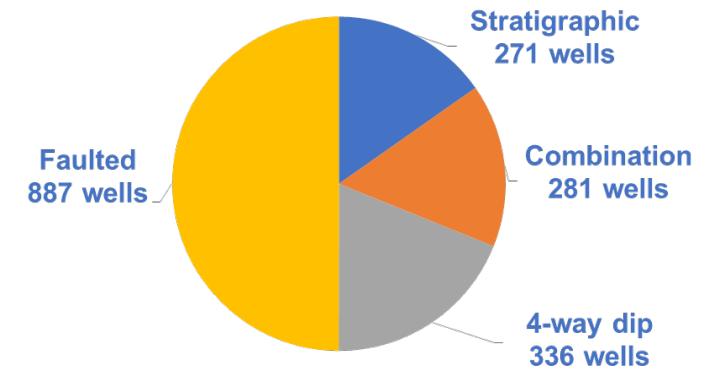
Definitions



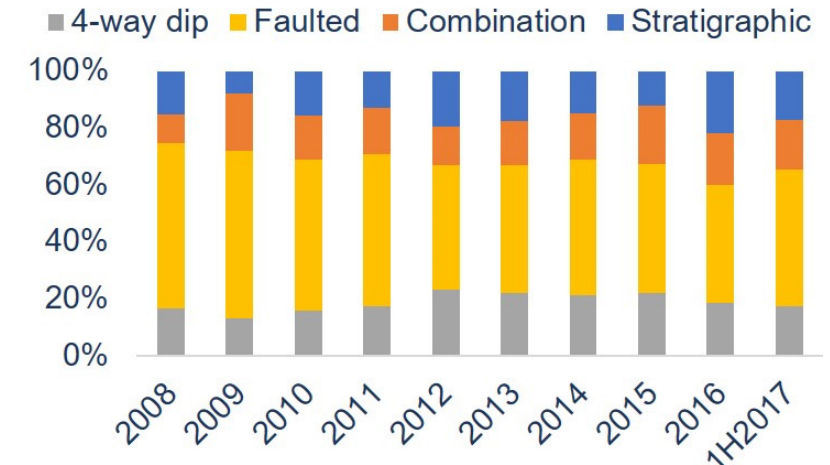
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- WGE Wildcat Database – subset of 1,775 exploration wells drilled 2008-1H2017, using publically available data
- 4 trap types
 - Stratigraphic
 - Combination
 - Faulted
 - 4-way dip
- Stratigraphic traps in this study: Clastics, Pinch-out – Carbonates excluded
- Spectrum between pure stratigraphic and combination traps
- Only 15% of exploration wells targeted stratigraphic traps
- 50% targeted faulted traps

Proportion of trap types for 1,775 Exploration wells drilled between 2008-1H2017



Exploration Drilling by Trap Type



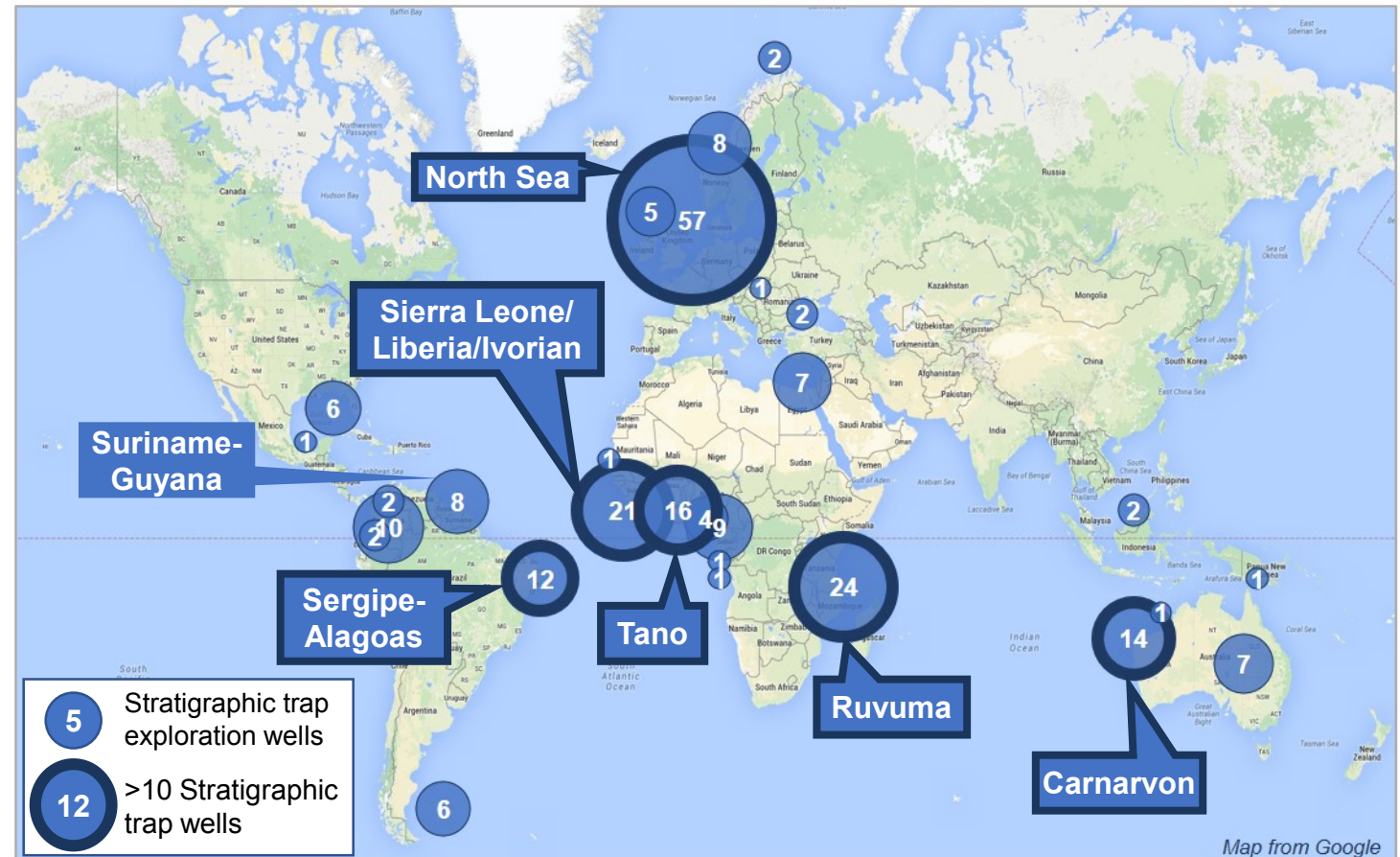
Stratigraphic Trap Location



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Number of stratigraphic traps in basins with >10 exploration wells drilled during 2008-1H2017

- Only 6 basins have more than 10 stratigraphic traps drilled



Source: WGE Wildcat Database

Stratigraphic Trap Plays



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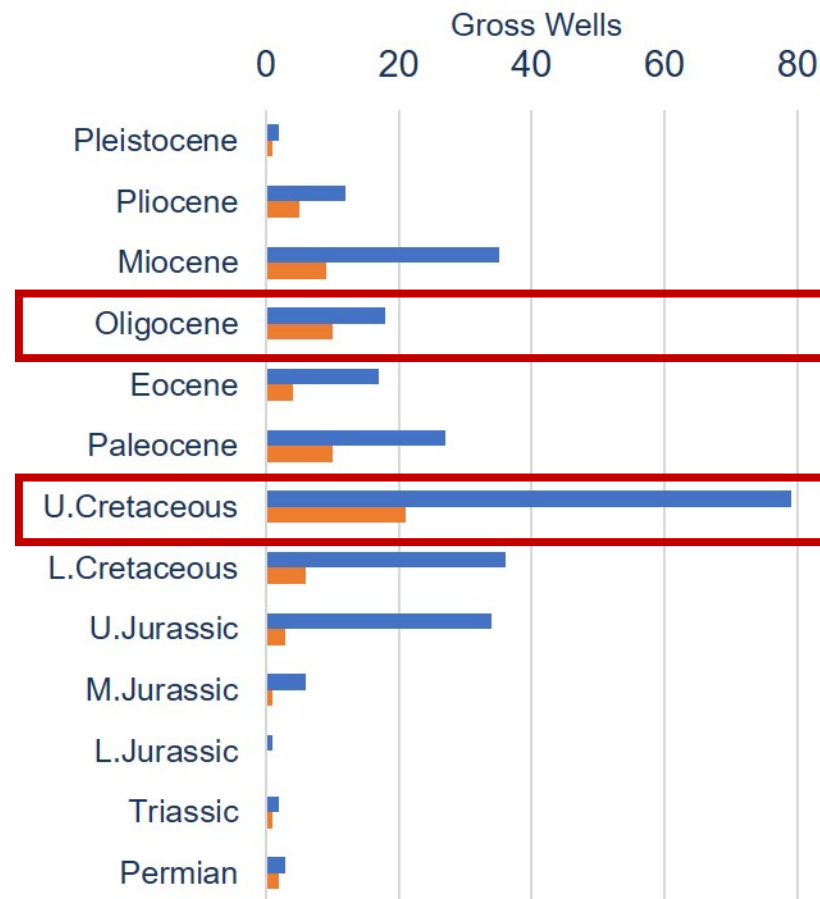
Tertiary and Cretaceous plays are associated with:

- Deep water turbidite systems
- Deposited in front of major deltas
- Most are in passive margin settings

Minor stratigraphic traps in deltaic and fluvial reservoir plays

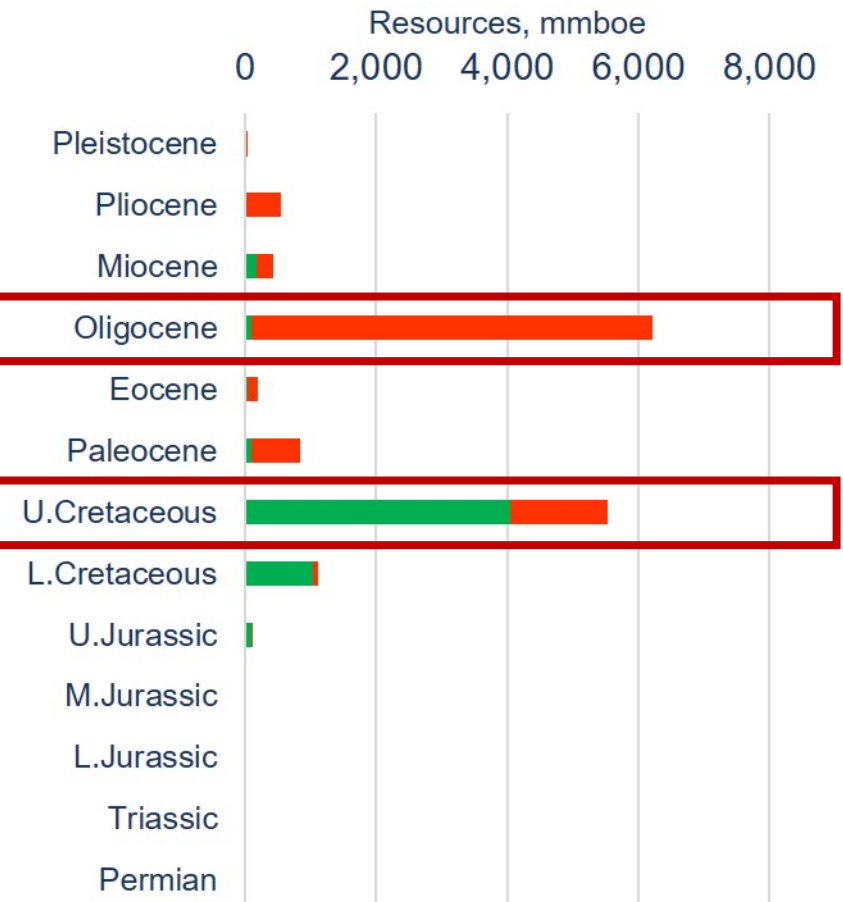
Stratigraphic Trap Exploration Wells and Commercial Discoveries

■ Exploration Wells ■ Commercial Discoveries



Stratigraphic Trap Discovered Resources

■ Oil ■ Gas



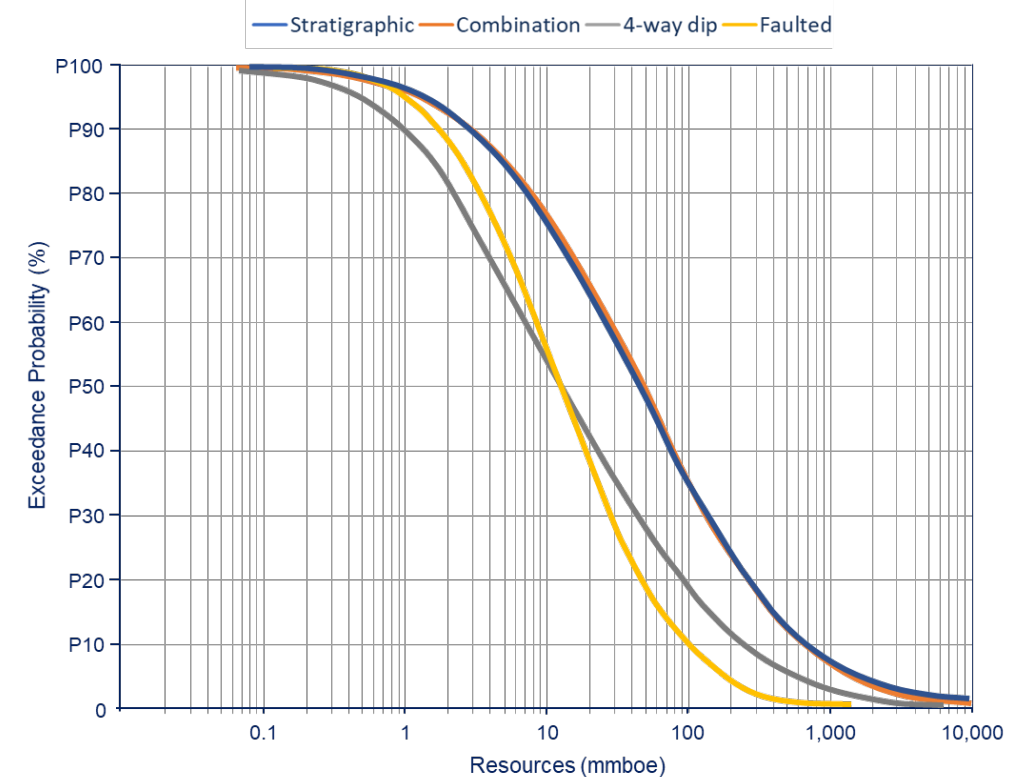
Resource Distributions



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- Stratigraphic and combination traps have the widest resource distribution
- Faulted traps have a narrow range and small mean resources – Large fault blocks have already been drilled
- The future is more stratigraphic

Discovered Resource Probability Distribution by Trap Type
(2008 – 1H2017)



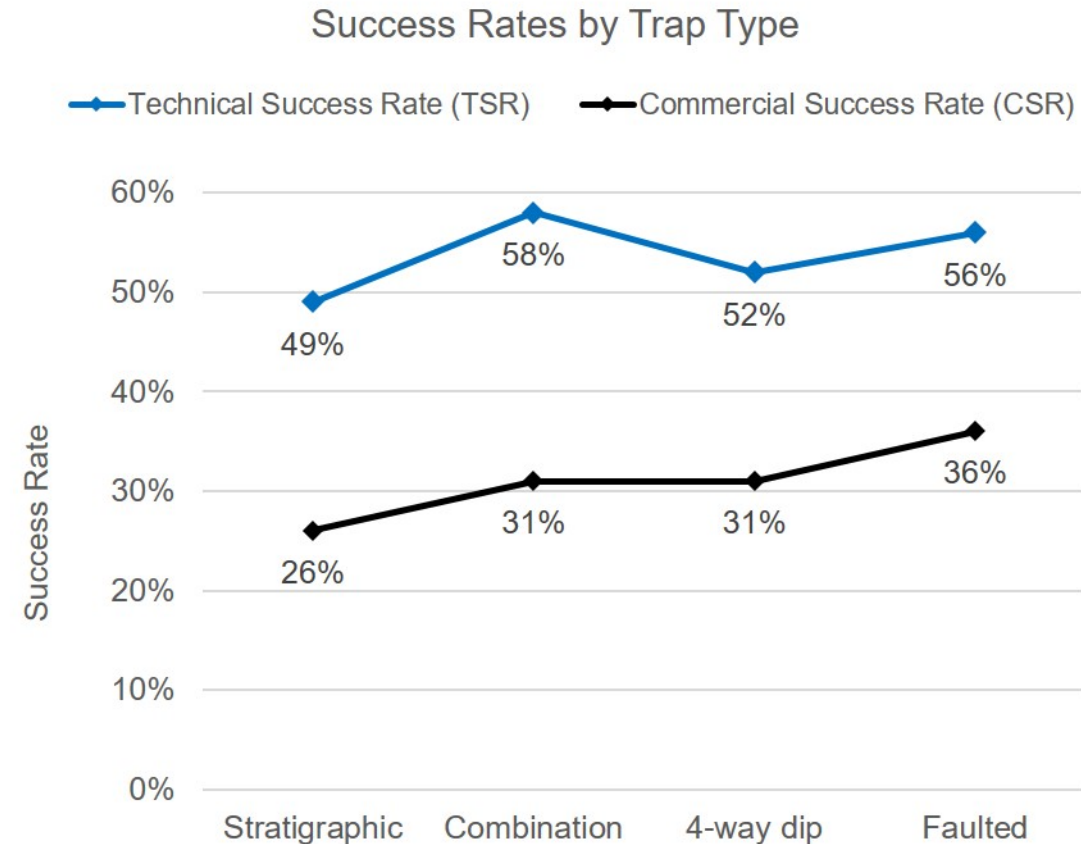
	Resource Probability Distribution (mmboe)					
Trap Type	P90	P50	Mean	P10	P1	# Wells
Stratigraphic	3	46	490	740	5,700	72
Combination	3	50	460	740	5,350	102
4-way dip	1	13	210	270	2,400	104
Faulted	2	13	46	100	450	314

Global Performance



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- Stratigraphic traps have a Technical Success Rate (TSR) only 3% points lower than 4-way dip closures
- Commercial Success Rate (CSR) gap is larger
- TSR proxy for Technical COS (P_g)
- CSR proxy for Commercial COS (P_c)
- Does a lower success rate mean that stratigraphic traps are more risky?

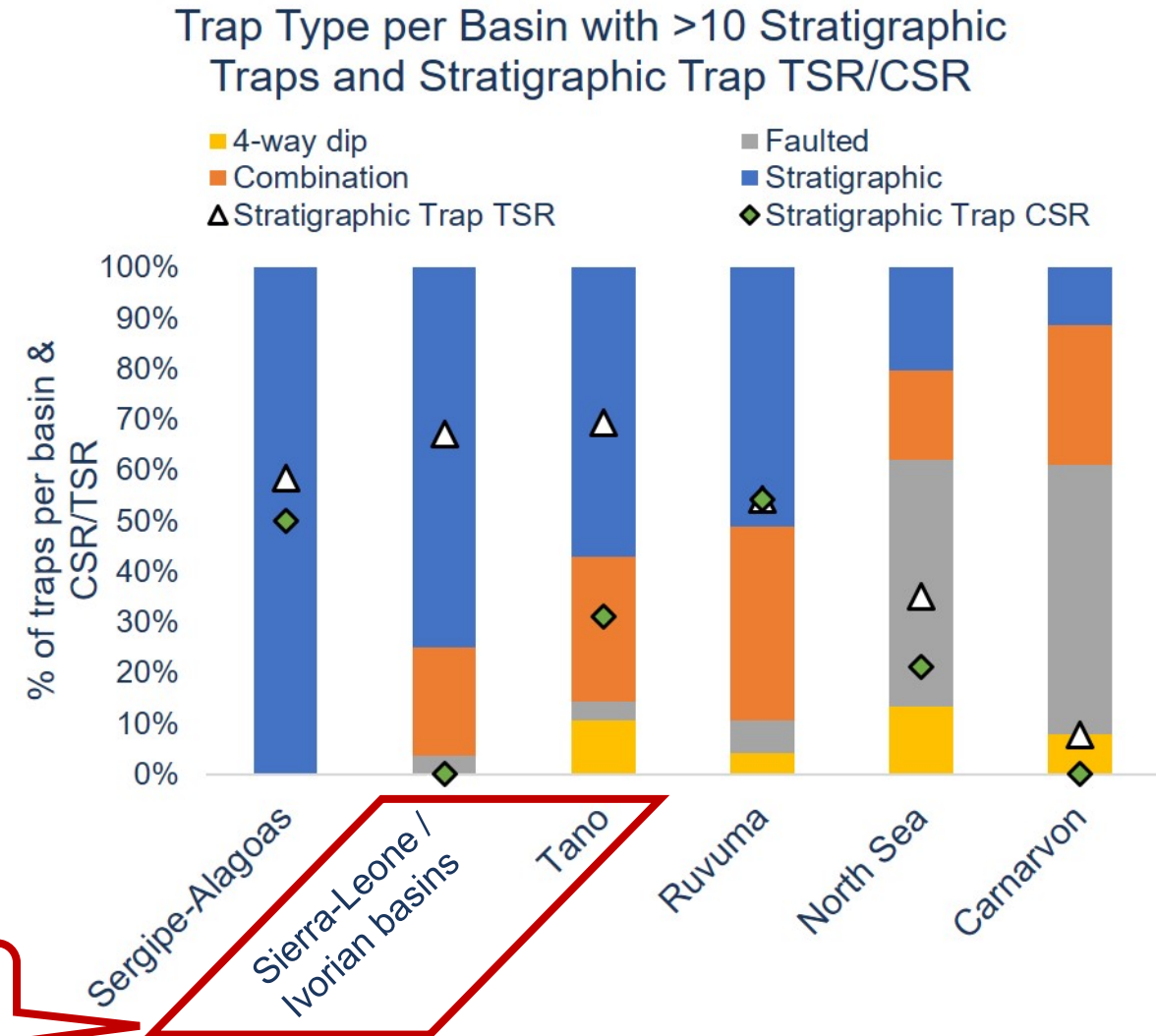


Not all basins are equal



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- Stratigraphic traps of the Africa Transform Margin Late Cretaceous play have ~70% TSR.
- Only the Tano Basin has delivered commercial resources on the Africa Transform Margin.
- North Sea and Carnarvon – low success rate in mature basins

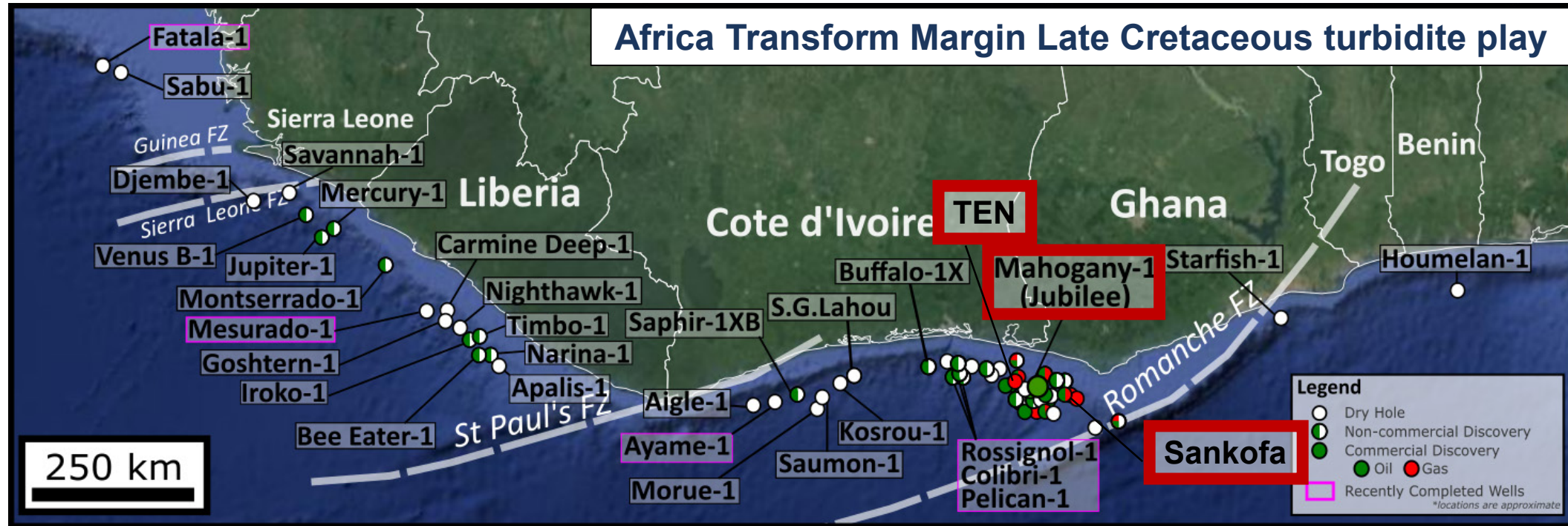


Late Cretaceous play of
Africa Transform Margin

The search for Jubilee “look alike”



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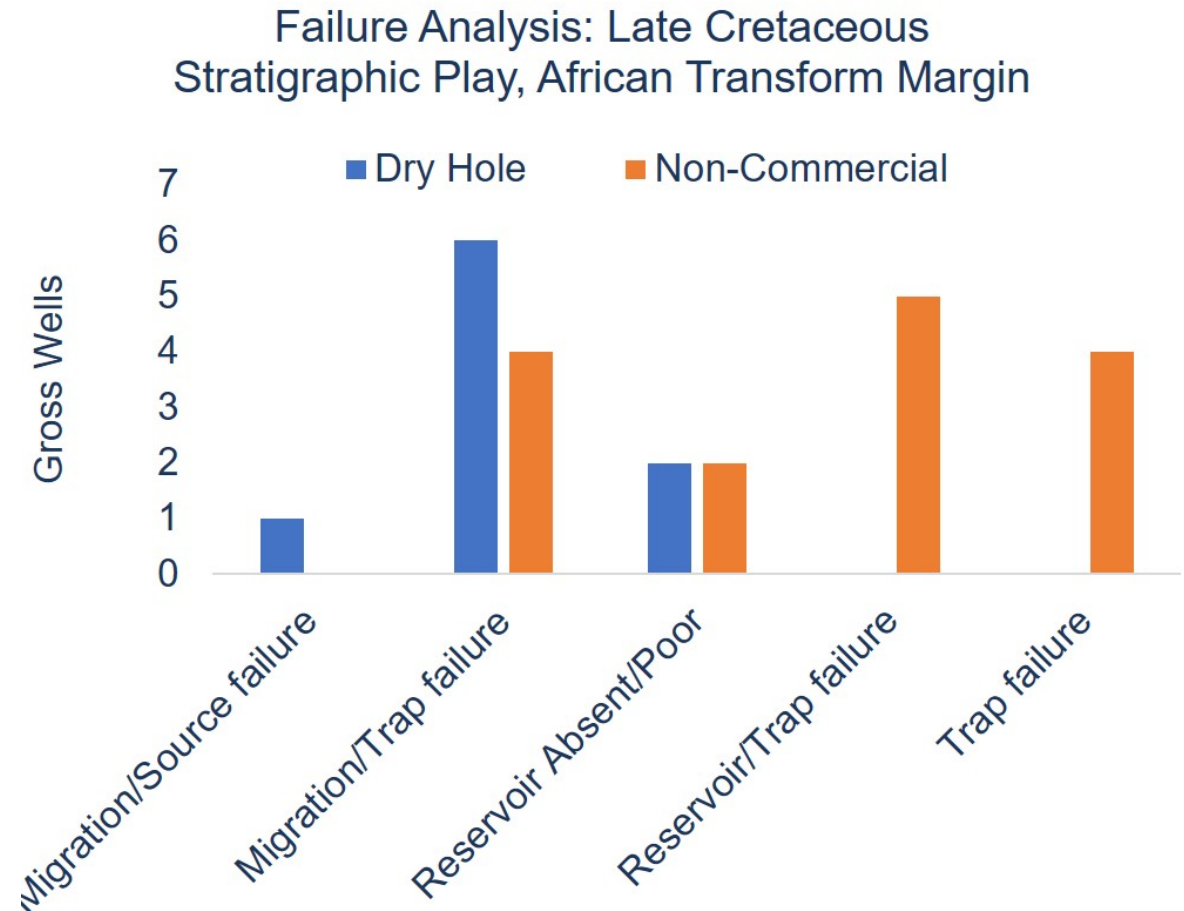
- Jubilee discovery in 2007
- 59 exploration wells post Jubilee – 23 dry, 26 non-commercial (44%)
- TEN (Tweneboa, Enyenra, and Ntomme) discoveries in 2009 to 2012
- Sankofa-Gye Nyame discoveries in 2009 and 2011

Why is it not working?



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- **Dry hole failure:**
Dominated by migration/trap failure category in 66%
(= reservoir of reasonable quality with minor shows)
- **Non-commercial failure:**
 - Reservoir and trap = GRV on low side of expectations
 - Charge: some under-filled accumulation and complex timing of migration



More powerful question: Why is it working?



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Tano basin

Structure of the South Tano High influences:

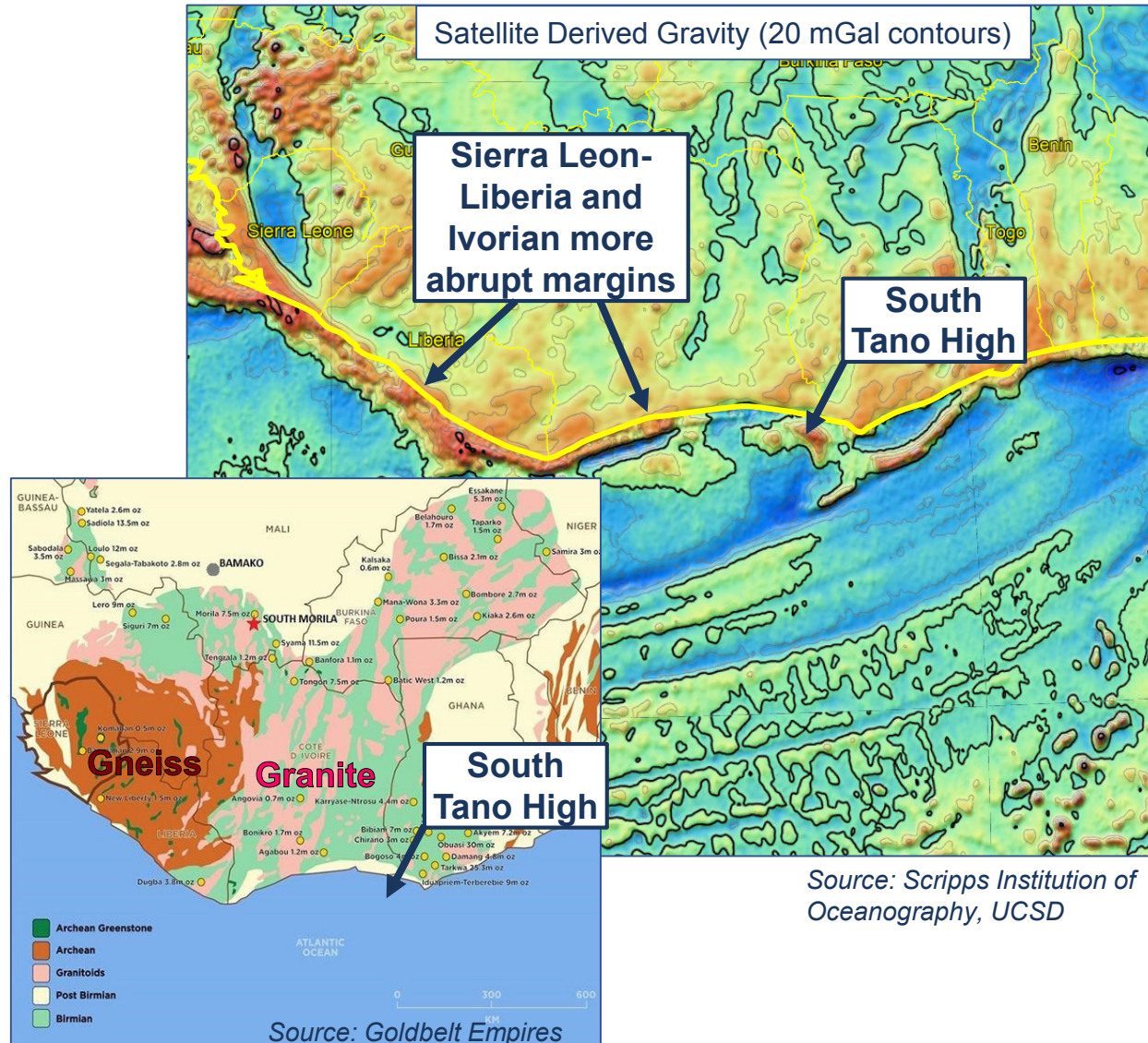
1. Focal point for turbidite systems
2. Focal point for hydrocarbon migration

Ivorian and Sierra Leone-Liberia margins

Elongated more abrupt margin:

1. Isolated turbidite systems
2. Lack of well defined hydrocarbon migration focal points

Source of sediments



Has the “trap” been unfairly blamed?



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Failure and Success Analysis highlights that:

- Low commercial success rate of the Late Cretaceous turbidite play can be due to more profound causes than just “the trap”:
 - Lack of hydrocarbon charge focus leading to potentially under-filled traps
 - Complex timing & migration
 - Lack of sufficient connected turbidite systems
- The “trap” is not always the weakest link of the 5 petroleum system elements

Stratigraphic Traps in Mature Basins



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- **North Sea:**

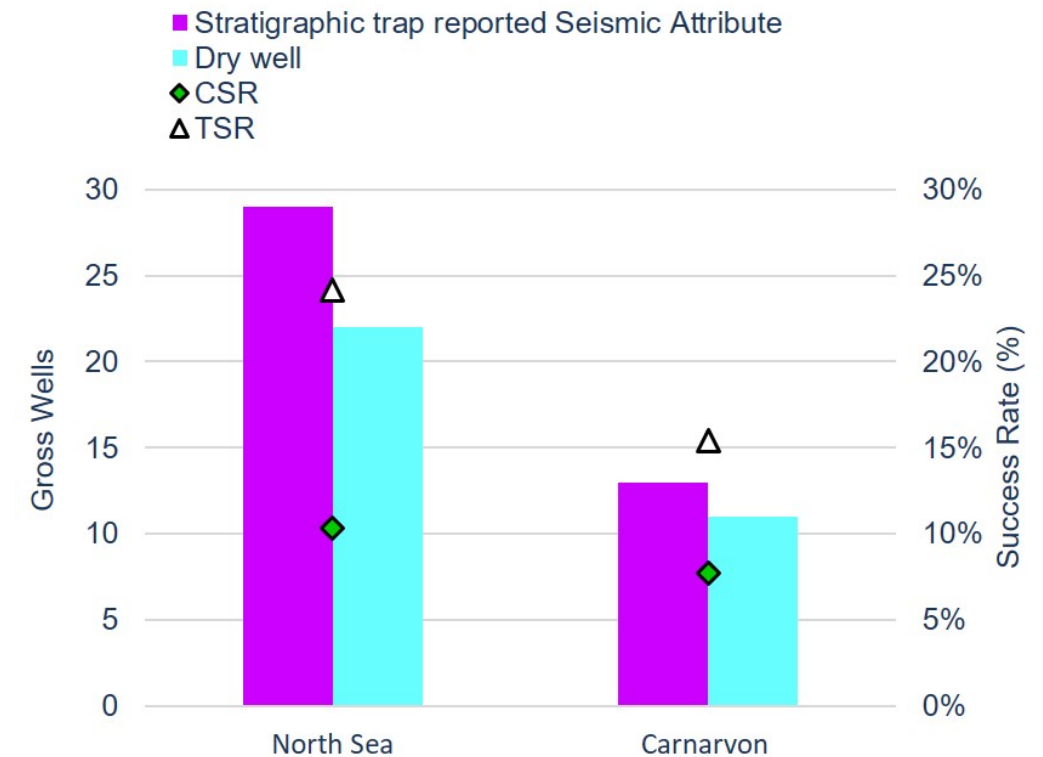
- 57 stratigraphic traps tested between 2008-1H2017 - Largest population
- Tertiary, Early Cretaceous and Late Jurassic plays
- Stratigraphic traps failure analysis by OGA¹: “Trap” is 36% of failure causes
- 75% of seismic attribute supported stratigraphic traps are dry (WGE Wildcat)

- **Carnarvon Basin:**

- Triassic, Jurassic and Early Cretaceous plays
- 14 stratigraphic traps, 1 commercial discovery, 1 non-commercial discovery
- All prospects defined by seismic attributes

- Is stratigraphic trap failure related to over-dependence on geophysical tools?

Stratigraphic Trap supported by Seismic Attributes



Source: WGE Wildcat Database

¹ Moray Firth – Central North Sea Post Well Analysis, Dec 2015. OGA

Conclusions



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- Stratigraphic traps are not more risky than other traps - their Technical Success Rate can reach 70% in some areas
- They are still a minority but will become an increasingly important exploration focus
- They have larger volume potential than remaining structural traps
- Stratigraphic traps have been unfairly blamed for other play element shortfall and current limitation of geophysical tools in some plays
- Commercial Success Rate can be improved when the “trap” element is fully integrated into the entire petroleum system

Q: Are stratigraphic traps more risky?

A: They don't appear to be

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