

Onshore Exploration Drilling Success in Southern Basin, Trinidad*

Xavier Moonan¹ and S. Harrypersad¹

Search and Discovery Article #11293 (2020)**

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Abstract

From 1857 to present, some 13,000 oil wells have been drilled onshore Southern Basin of Trinidad producing more than 1.5 billion barrels of oil to date, primarily from Late Miocene to Pleistocene deltaic sandstones. Just under 2000 of those wells drilled and tested Middle Miocene deep-water turbidites, with less than a hundred testing Cretaceous reservoirs. With scores of old, abandoned and to some extent stratigraphically mature fields scattered along its length and breadth, and the ever-increasing rate of decline of the country's oil production, the basin required a new wave of exploration, to stratigraphically older and deeper reservoirs. In 2013, the Ministry of Energy launched an Onshore Bid Round, the first in just 15 years. Three blocks adjacent to established oilfields with production primarily from Middle Miocene Herrera deep-water turbidite sandstones, were marketed and 11 bids were received. The Rio Claro Block was awarded to Lease Operators Limited; the St. Mary's Block was awarded to Range Resources and the Ortoire Block was awarded to Touchstone Exploration. Each block entailed minimum work obligations of 4 exploration wells each to targets of at least 5000ft. In 2019, the exploration drilling campaign kicked off for both Lease Operators Limited and Touchstone Exploration. LOL drilled their Ah Yah Yie well to a TD of 6150ft encountering stratigraphy as old as Early Miocene. Unfortunately, the well failed to encounter effective reservoirs and was plugged and abandoned. LOL's second well, Barakat was drilled in vicinity of the Balata East field, where it encountered oil bearing Herrera sandstones in structures on trend with the Balata East thrust sheet. This well has thus proven that the current oilfield can be extended with careful outstep drilling into tear fault bound thrust sheets to the west and south west. Touchstone Exploration drilled their Coho well testing a SW plunging anticline immediate south of the Penal Barrackpore anticlinal trend, in the Tableland area and successfully discovered gas and condensate in Herrera sands within two thrust sheets. Touchstone's Cascadura well was then drilled testing a structure on trend with Penal Barrackpore anticline immediately south of the town of Rio Claro. The well encountered three Herrera thrust sheets as prognosed with oil bearing sandstones at two structural levels. The lowermost of these sandstones appear to be near vertical to overturned and correlates well with the Overturned Limb or Intermediate Herrera from Penal Barrackpore. A string of successful drilling, supported by extensive structural modelling, has breathe new life back into Southern Basin, de-risking adjacent prospects and opening more opportunities for exploration investment. Adamant optimism, sound geological concepts and supportive policies are the fundamental principles to ensuring the rejuvenation of T&T's hundred-year-old industry.



AAPG

Latin America & Caribbean Region

SURINAME 2019

Geosciences Technology Workshop

Onshore Exploration Drilling Success in Southern Basin, Trinidad

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Touchstone Exploration



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- Lease Operators Limited
- Upstream Management Limited
- Touchstone Exploration Trinidad Limited



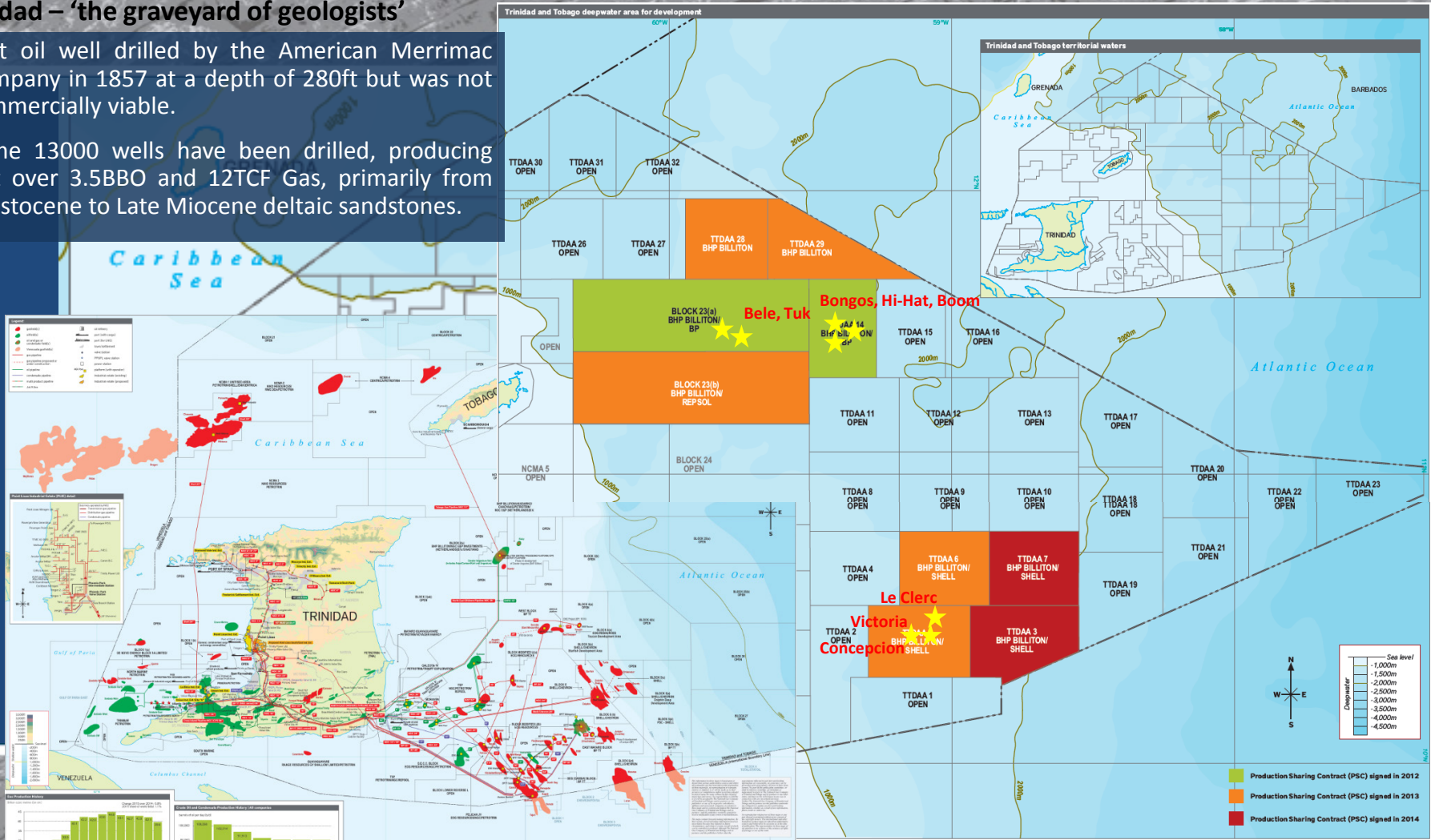
Government of the Republic of Trinidad and Tobago
Ministry of Energy and Energy Industries



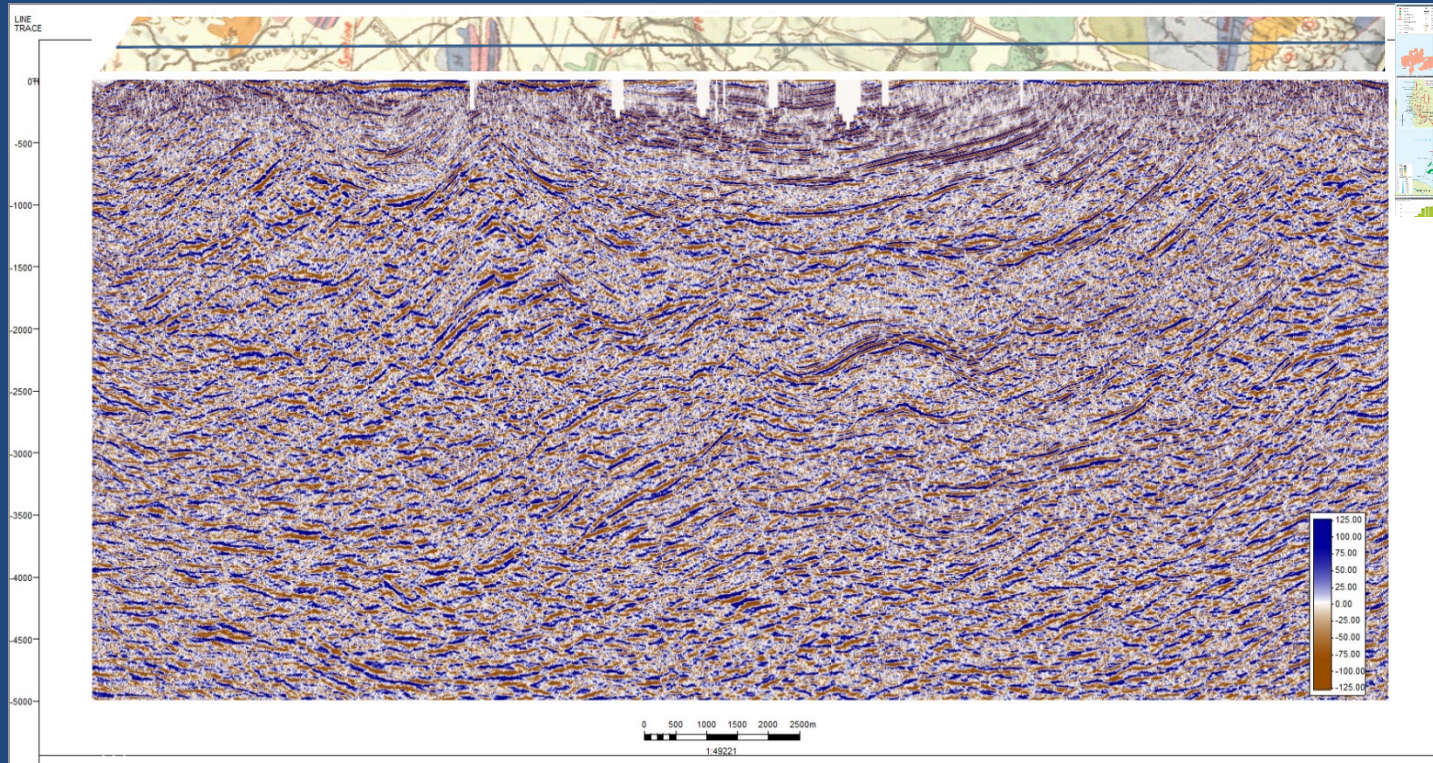
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Trinidad – ‘the graveyard of geologists’

- First oil well drilled by the American Merrimac Company in 1857 at a depth of 280ft but was not commercially viable.
- Some 13000 wells have been drilled, producing just over 3.5BBO and 12TCF Gas, primarily from Pleistocene to Late Miocene deltaic sandstones.

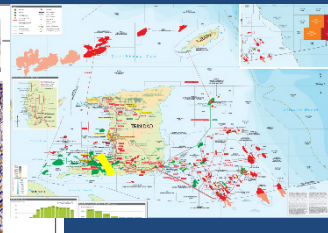
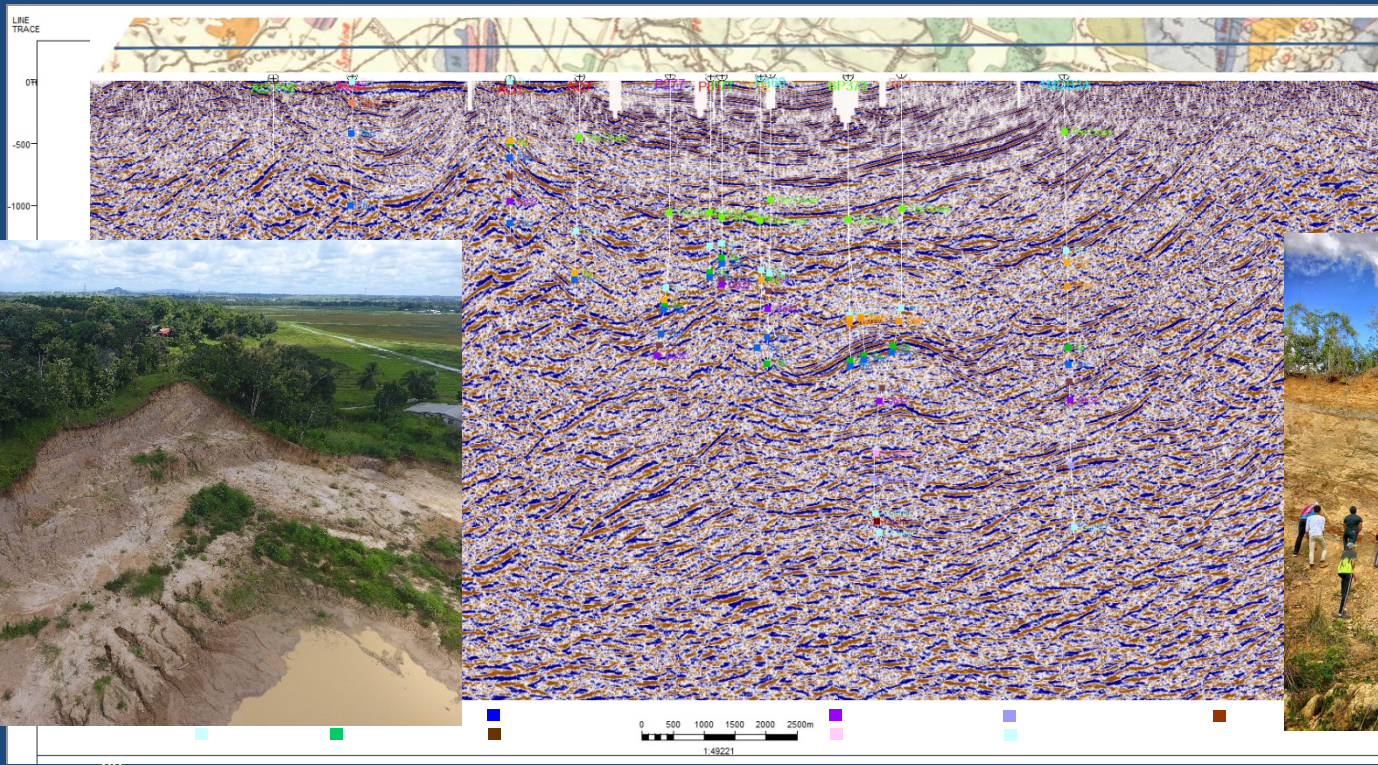


The imaging challenge – Onshore Southern Basin Consortium 2D Seismic Line TD 91-177



- Acquired and processed by Halliburton Geophysical for Exxon Trinidad Ltd and SBC partners in 1991
- Symmetrical split spread. Total Line length 21km.
- 20m hole depth, 15lb charge size. 240 channels, sample rate 2ms. 30m receiver station interval , 60m shotpoint station intervals
- 9 geophones per string, 2 geophone strings per group, array equally spaced. Fold coverage – 60
- Processed using standard Promax processing with AGC and predictive decon to remove multiples, noise and spiking
- There is risk of sideswipe artefacts

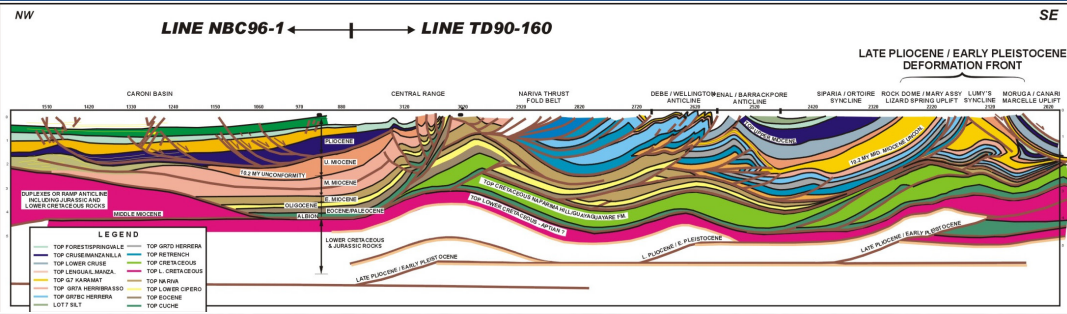
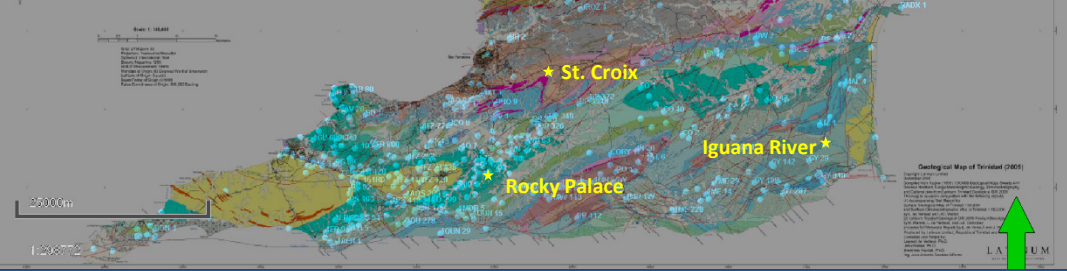
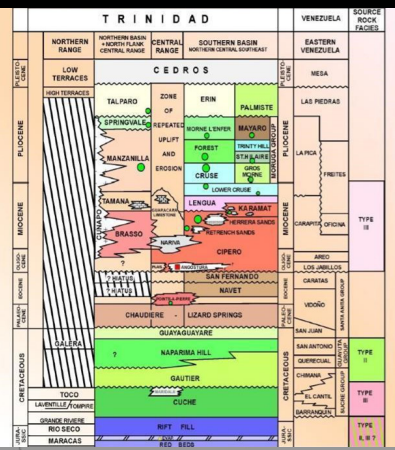
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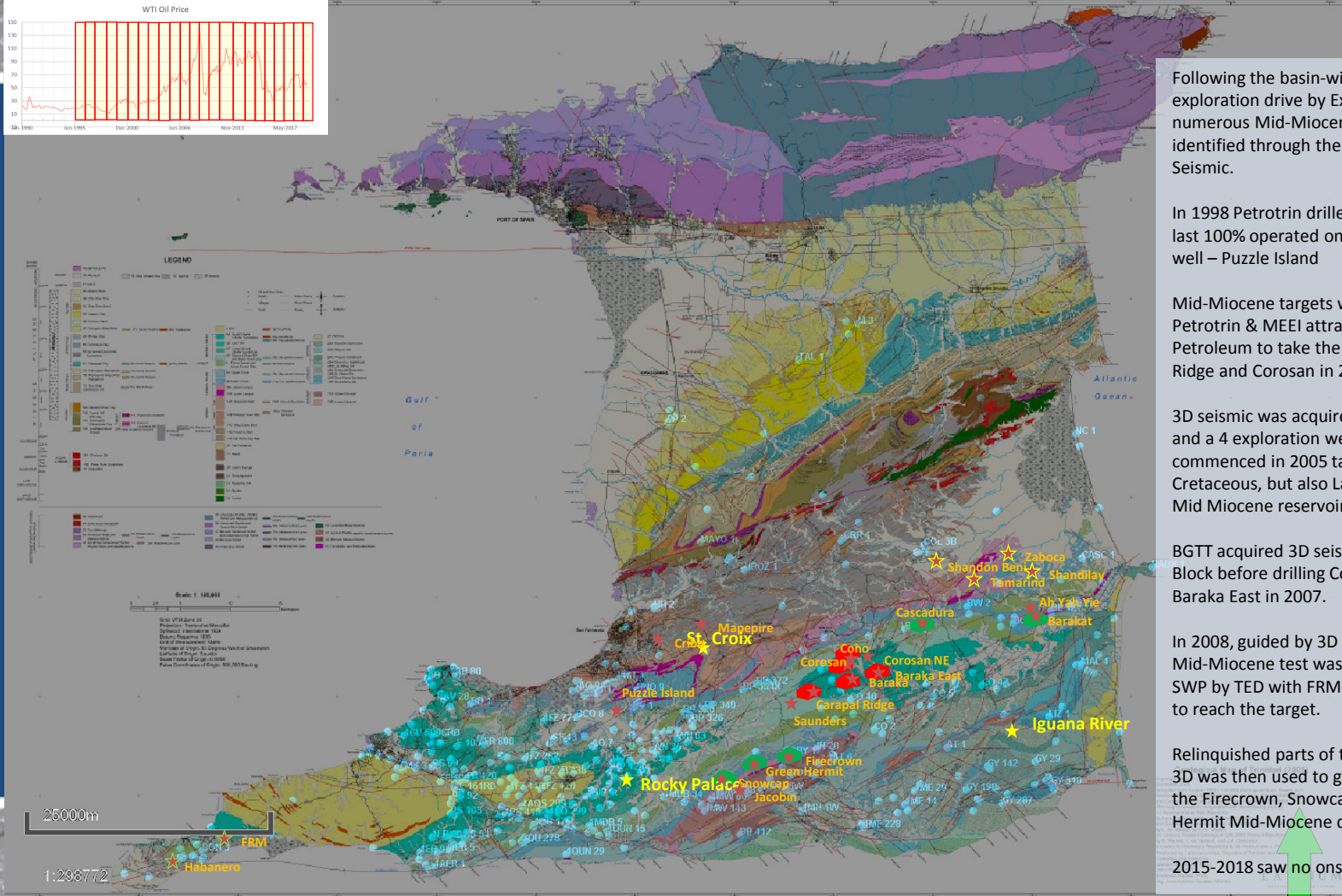
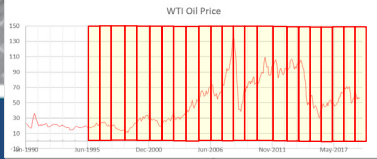
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- ## Southern Basin Consortium
- In 1989 Exxon, Total, Chevron, Trintoc and Trintopec come together to form the Southern Basin Consortium to explore the southern part of Trinidad for structures similar to El Furrial.
 - Three wells were drilled onshore –St. Croix-1, Rocky Palace-1 and Iguana River-1. All wells tested Cretaceous fold structures.
 - The wells penetrated Cretaceous sandstones, modeled by Exxon to be deep water turbidites, encased in shales.
 - All sandstones demonstrated residual oils or sub-commercial accumulations.
 - The St. Croix-1 well encountered Cretaceous shales that were mature. The shales at Rocky Palace-1 and Iguana River-1 were shown to be thermally immature as a potential source rock.



Leon Aden and Robert Bierley Exxon Exploration Company Houston USA;
**Structural Development of the Southern Basin, Onshore Trinidad:
 Implications for Hydrocarbon Entrapment**



Following the basin-wide Cretaceous exploration drive by Exxon and partners, numerous Mid-Miocene targets were identified through the use of the SBC 2D Seismic.

In 1998 Petrotrin drilled their first and last 100% operated onshore exploration well – Puzzle Island

Mid-Miocene targets were marketed by Petrotrin & MEEI attracting Vintage Petroleum to take the risk at Carapal Ridge and Corosan in 2001.

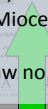
3D seismic was acquired for Talisman and a 4 exploration well campaign commenced in 2005 targeting primarily Cretaceous, but also Late Oligocene and Mid Miocene reservoirs.

BGTT acquired 3D seismic across Central Block before drilling Corosan NE and Baraka East in 2007.

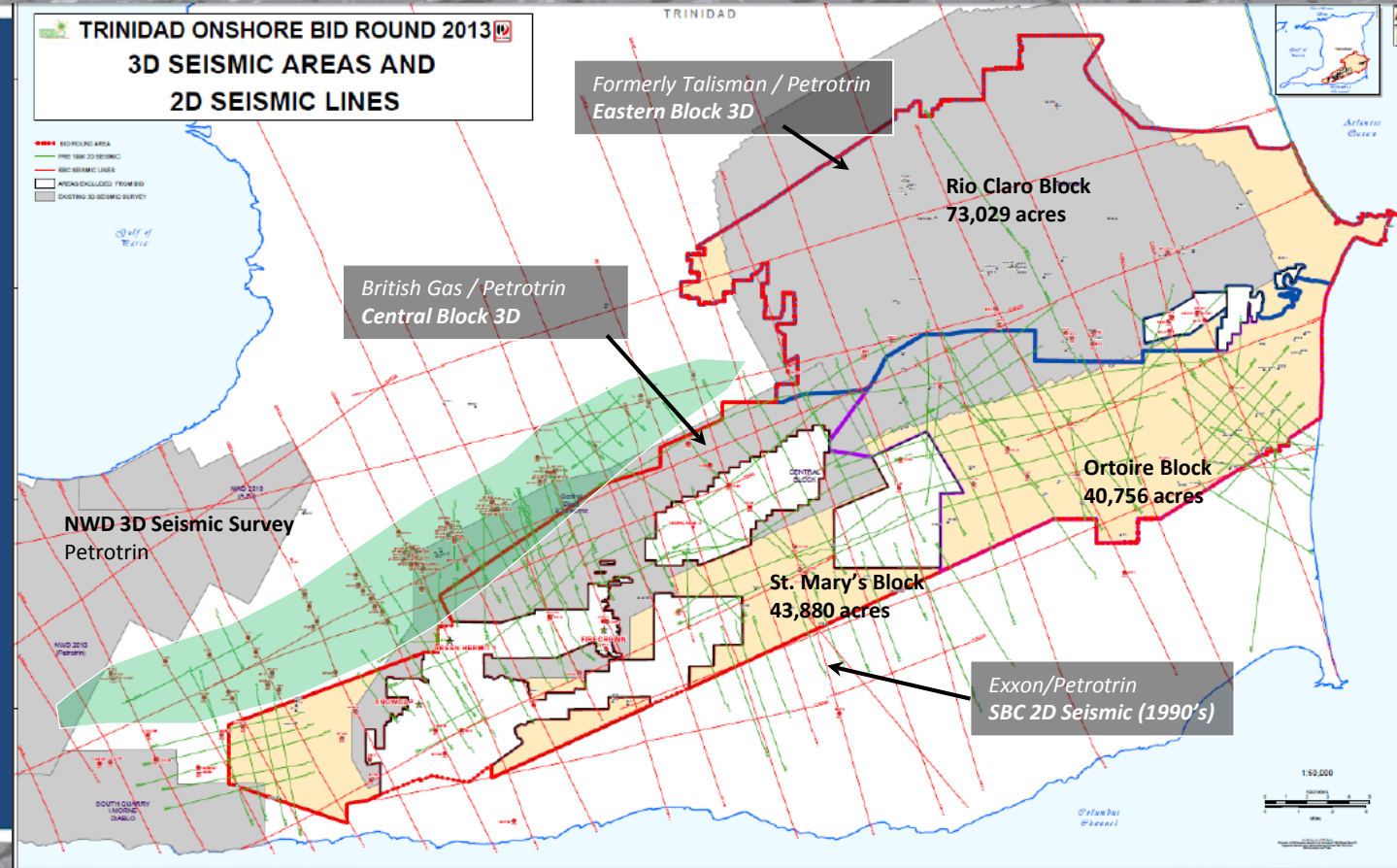
In 2008, guided by 3D seismic a deep Mid-Miocene test was attempted in SWP by TED with FRM-1 but they failed to reach the target.

Relinquished parts of the Central Block 3D was then used to guide and de-risk the Firecrown, Snowcap and Green Hermit Mid-Miocene discoveries.

2015-2018 saw no onshore exploration



Trinidad Onshore Bid Round 2013



Why Explore an 'explored' basin?

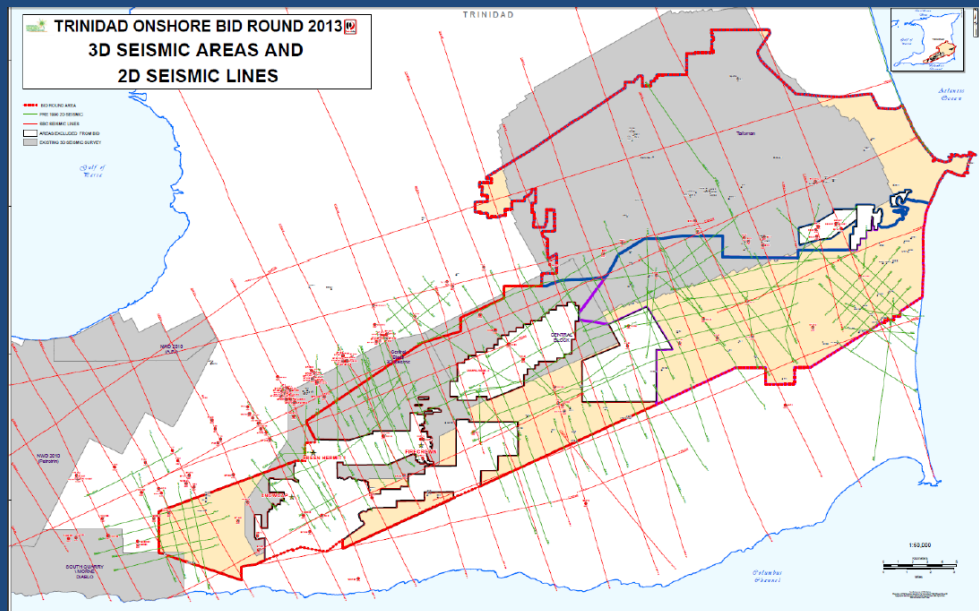
- Majority of wells drilled in the 1940's to late 50's.
- Biostratigraphy at its infancy and turbidite sandstone models were unheard of
- Logging tools had very limited vertical and horizontal resolution
- No 2D or 3D seismic at that time
- Lack of understanding of the kinematics in the deformation of shale rich stratigraphy
- Gas was seen as a nuisance and usually overlooked.

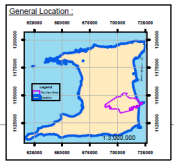
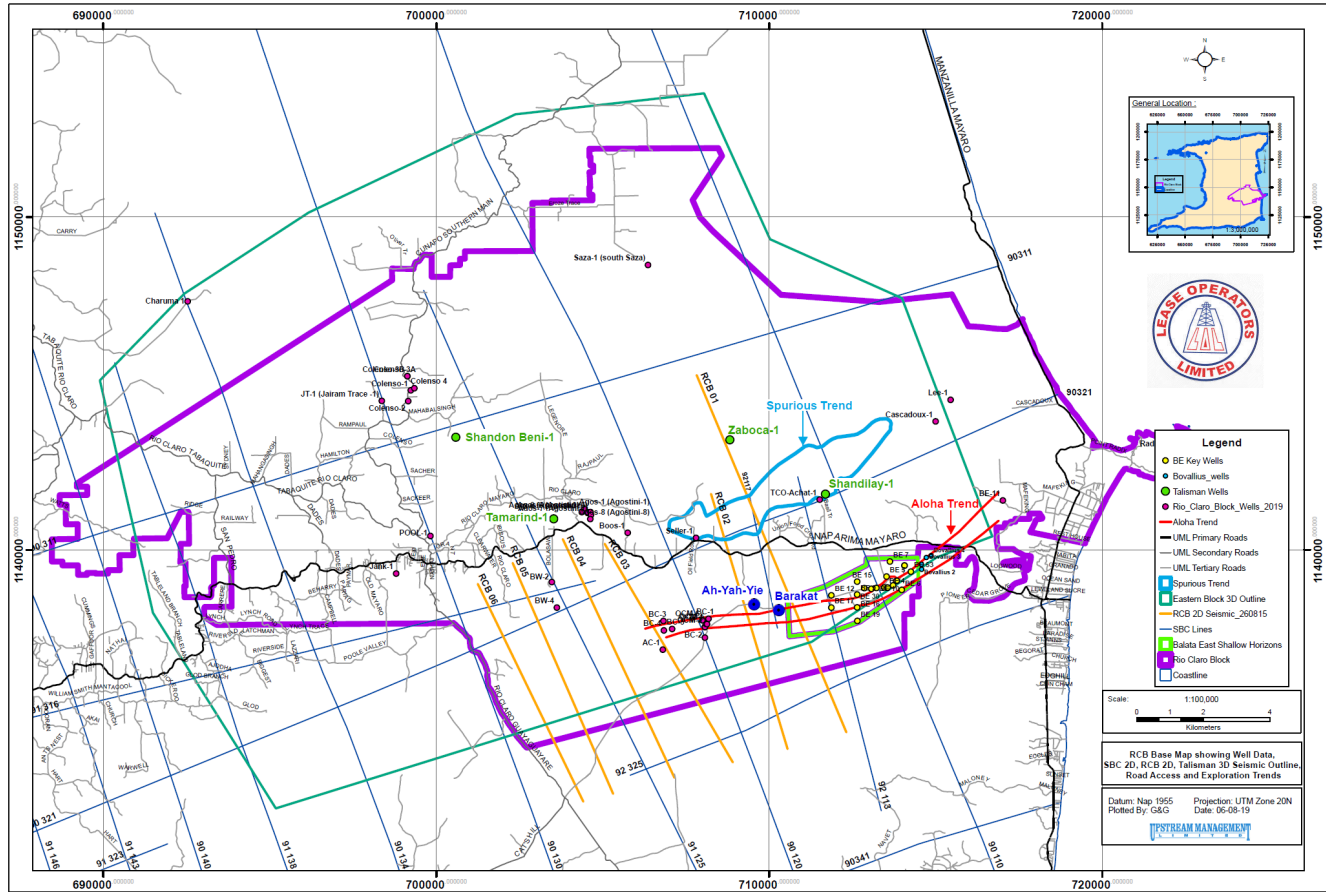
Current facilities and infrastructure are underutilized. Easy market of hydrocarbon and lots available workforce

What tools do we need to get it right this time?

- Region scaled mapping and application of analogues
- Strong Structural Geology background is a necessity:- overprinting of multiple phases of deformation, Mid Miocene sandstones are now understood to be syn-kinematic. As such both syn and post depositional tectonism has to be fully unravelled.
- A determined, highly optimistic but pragmatic team – Exploration Onshore Trinidad has had its toll on many a company and with more failures than successes in the last 20yrs a cloud of negativity has hung over many parts of Southern Basin for a long period of time.

RIO CLARO BLOCK



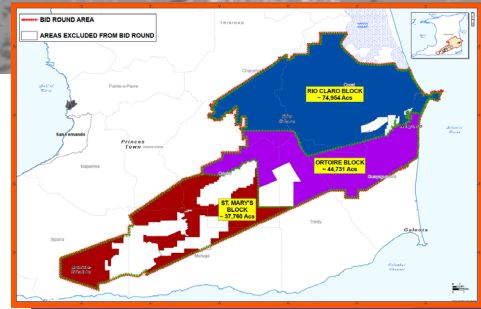


- Legend**
- BE Key Wells
 - Bovallus_wells
 - Talisman Wells
 - Rio Claro Block Wells_2019
 - Aloha Trend
 - UML Primary Roads
 - UML Secondary Roads
 - UML Tertiary Roads
 - Spurious Trend
 - Eastern Block 3D Outline
 - RCB 2D Seismic_260815
 - SBC Lines
 - Balata East Shallow Horizons
 - Rio Claro Block
 - Coastline



RCB Base Map showing Well Data,
SBC 2D, RCB 2D, Talisman 3D Seismic Outline,
Road Access and Exploration Trends

Datum: Nap 1955 Projection: UTM Zone 20N
 Plotted By: G&G Date: 06-08-19



AYY – BARAKAT Conceptual Model

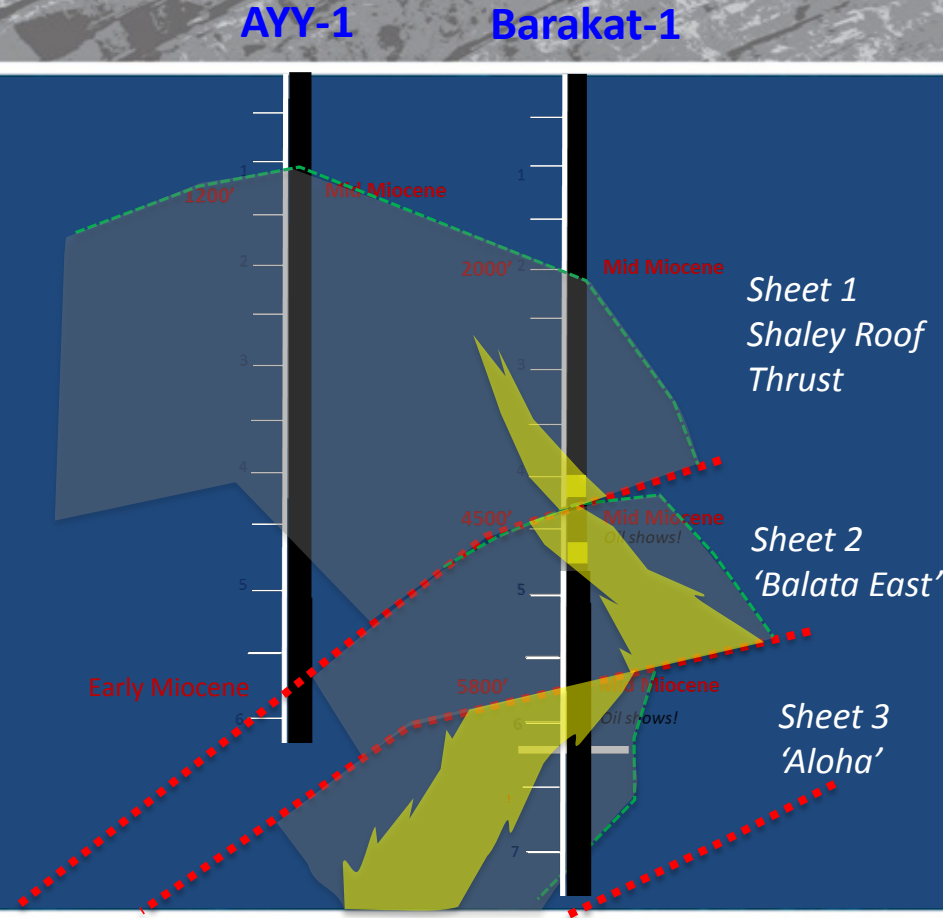
Drilled two exploration wells in Rio Claro Block today, both wells targeting the Mid Miocene Herrera turbidites:

1. Ah Yah Yie – 6220 TD
2. Barakat – 7400 TD

Ah Yah Yie was dry.

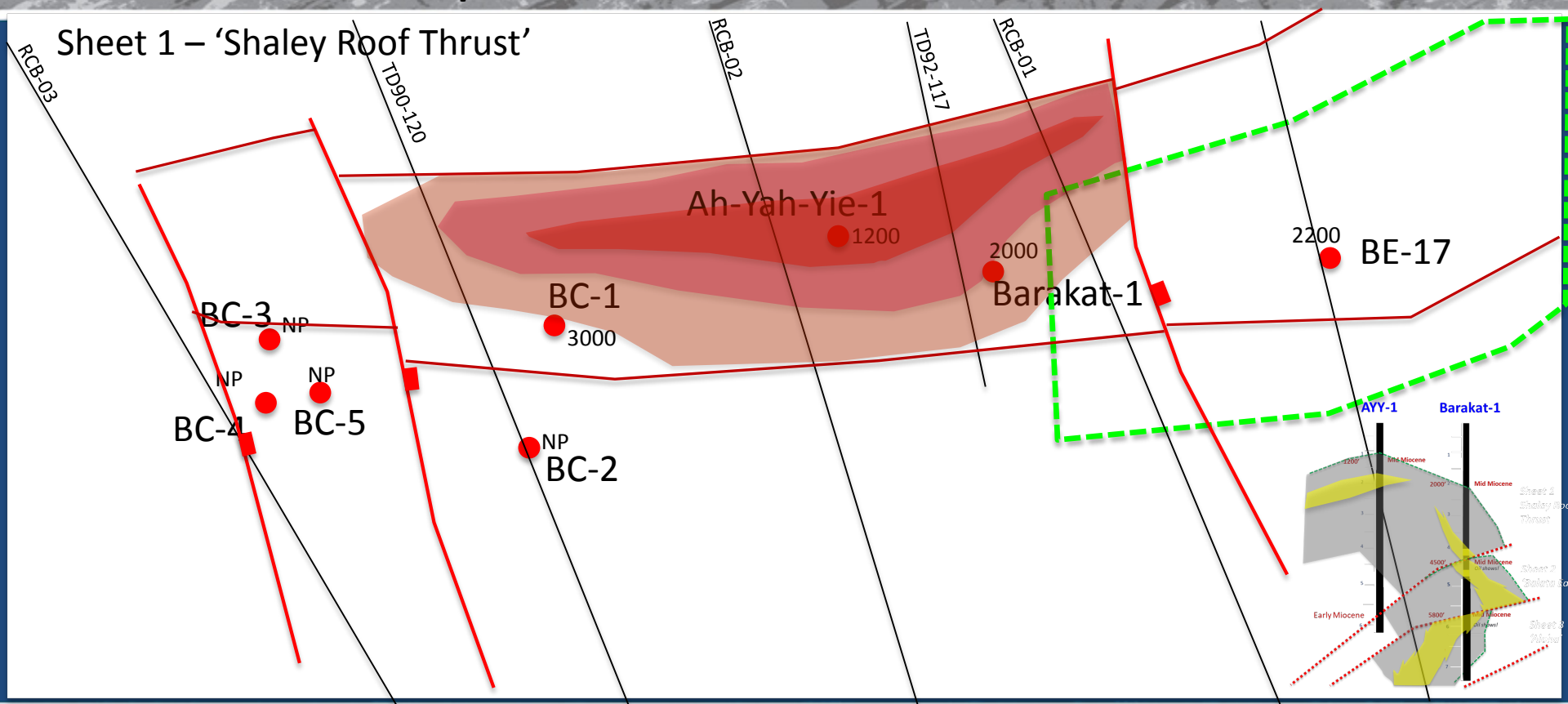
Barakat has indications of a significant oil pool along the Aloha Trend from Bouvallius in the east to Balata Central to the west.

A future well will test the 'Spurious Trend' which is a Late Oligocene Nariva sandstone play



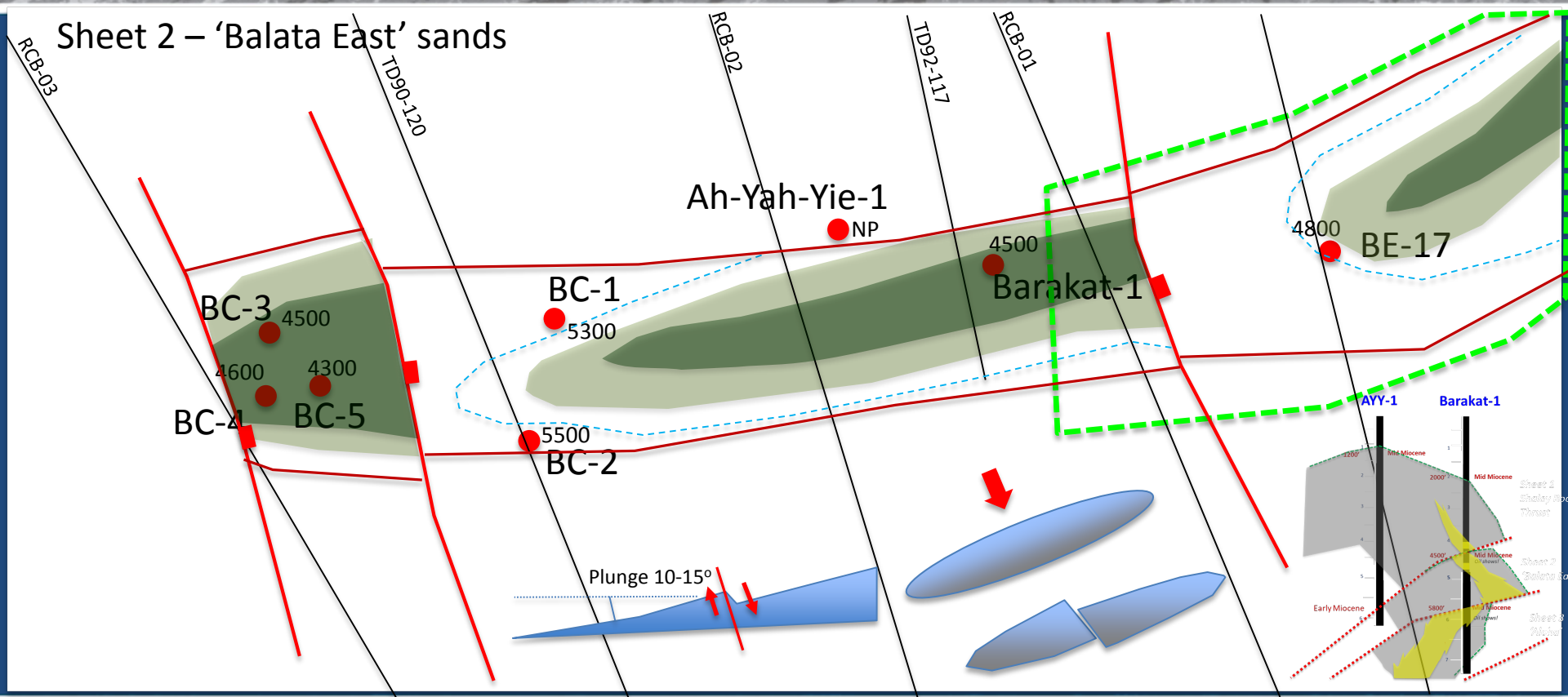
AYY – BARAKAT Conceptual Model

Sheet 1 – 'Shaley Roof Thrust'



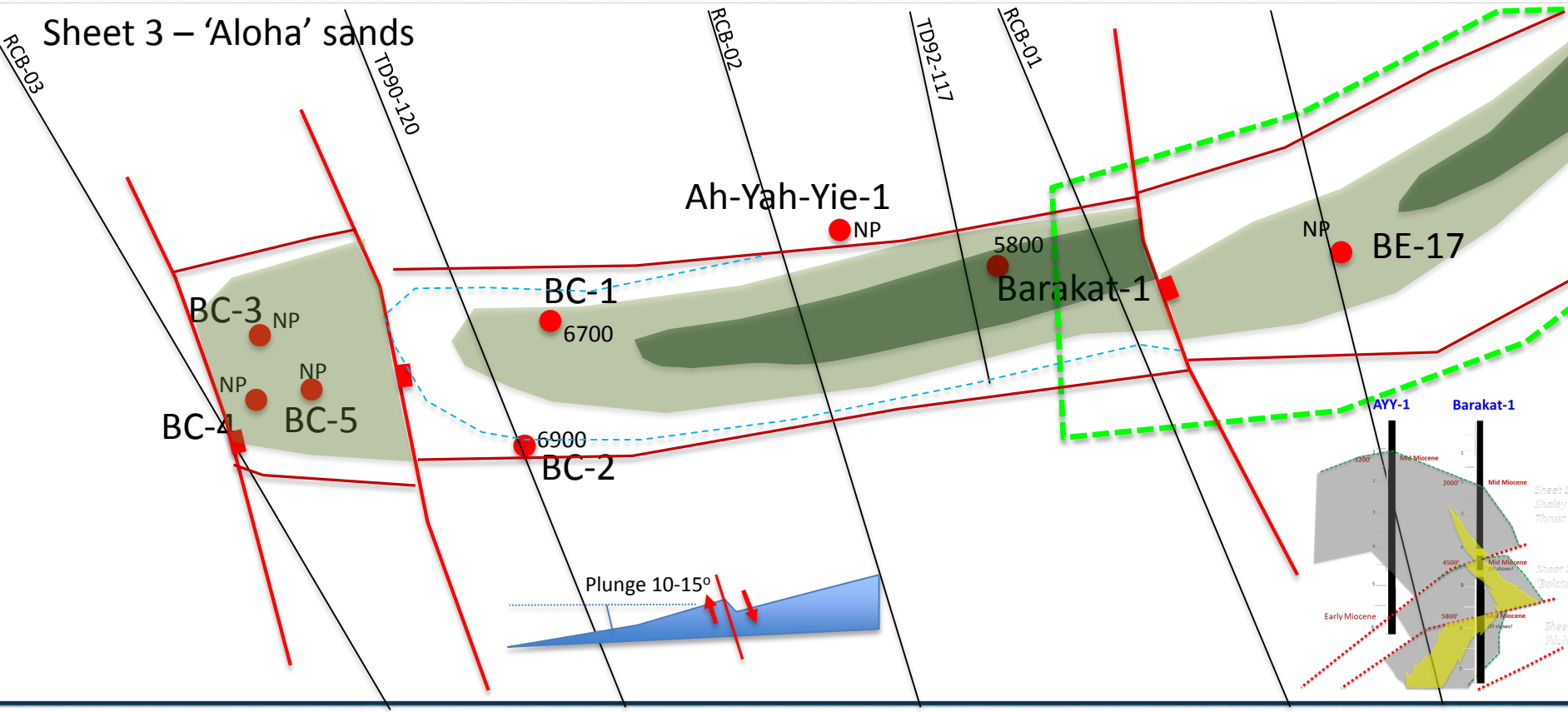
AYY – BARAKAT Conceptual Model

Sheet 2 – 'Balata East' sands

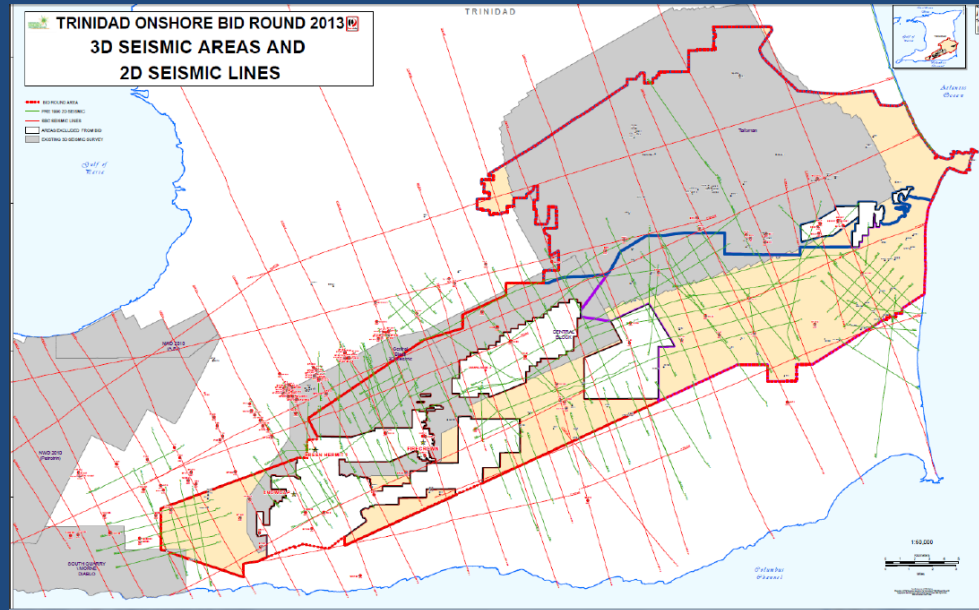


AYY – BARAKAT Conceptual Model

Sheet 3 – 'Aloha' sands

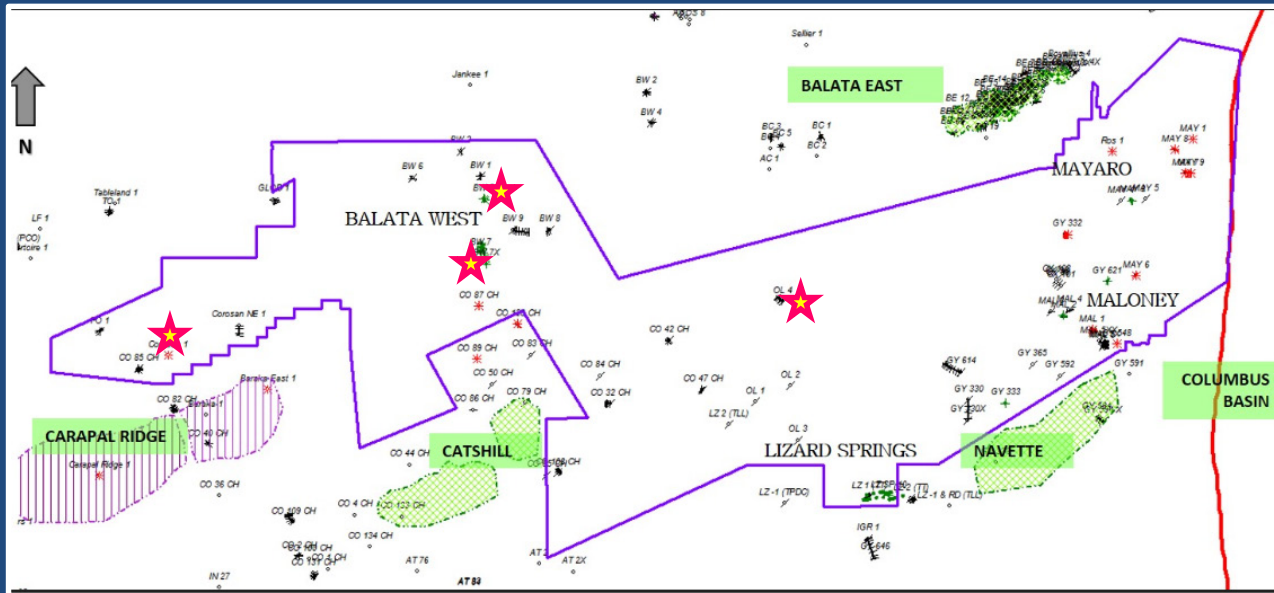


ORTOIRE BLOCK



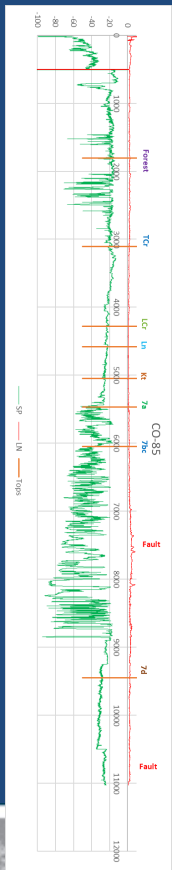
Exploration Methodology - Existing Wells

Well stock ~ 30 wells to start, ended up with 77 wellbores, 73 surface locations including an entire field of 22 wells unknown to the MEEI at this time!

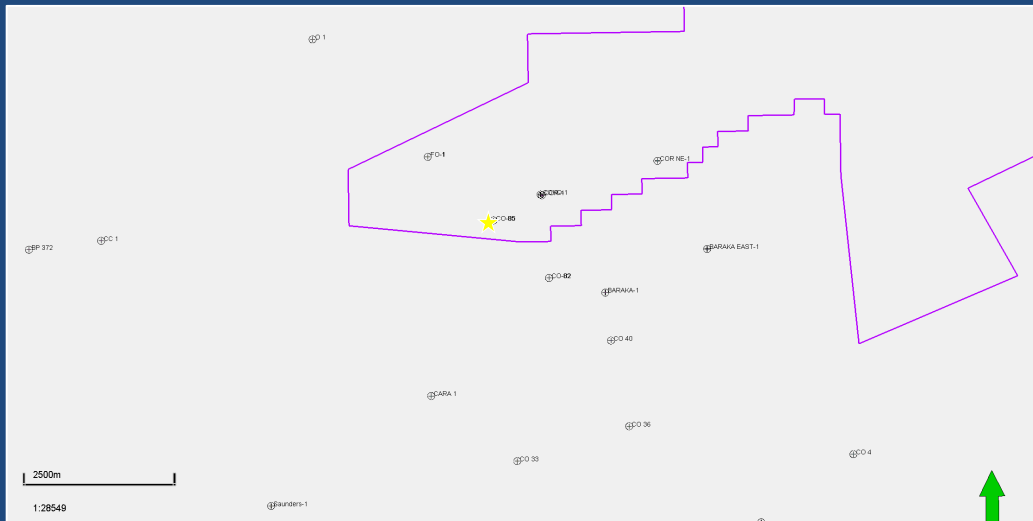


COHO-1
1st Exploration Well



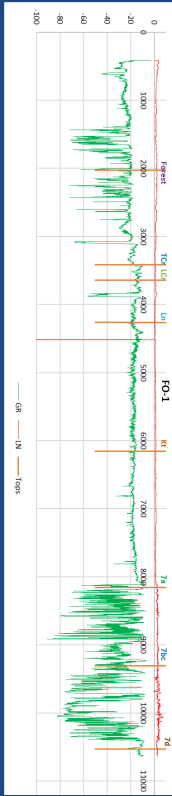


CO-85 (Catshill-85) was spud by Shell in August 1958, and drilled a normal succession encountering the Gg7 Karamat at 5025, Top Herrera sandstones at 5440ft. The well penetrated a backthrust fault around 7400ft and entered subthrust Herrera sandstones. At approximately 10975ft the well penetrated a south verging thrust and entered Karamat with Cipero affinities. It was approximated that to encounter the Herrera sandstones again will require another 1000-1500ft of drilling. TD was called at 11055ft. No production

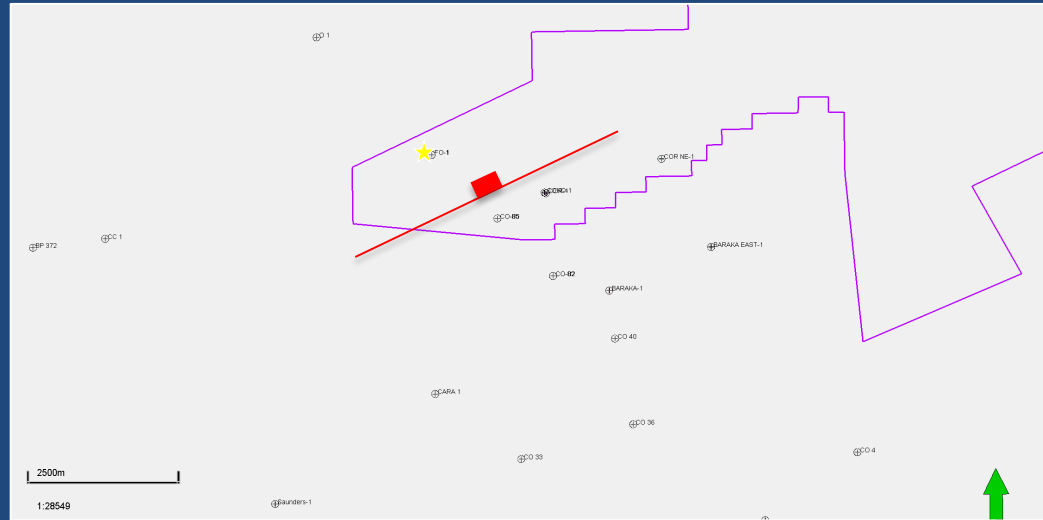


Shell's thinking at the time was that CO-85 did not drill through any thrust faults but rather drilled a very thick Mid Miocene unit ~3500ft

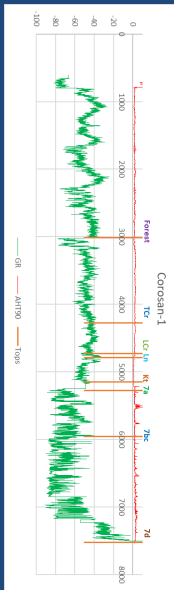
Dips from Karamat into Herrera interval all show a strong south easterly azimuth. Dip magnitude increases from 10° near top Herrera to a max of 78° at a depth of 7304ft (in vicinity of backthrust). Dips are generally south and south east thereafter until they switch to a northerly azimuth below the south verging thrust.



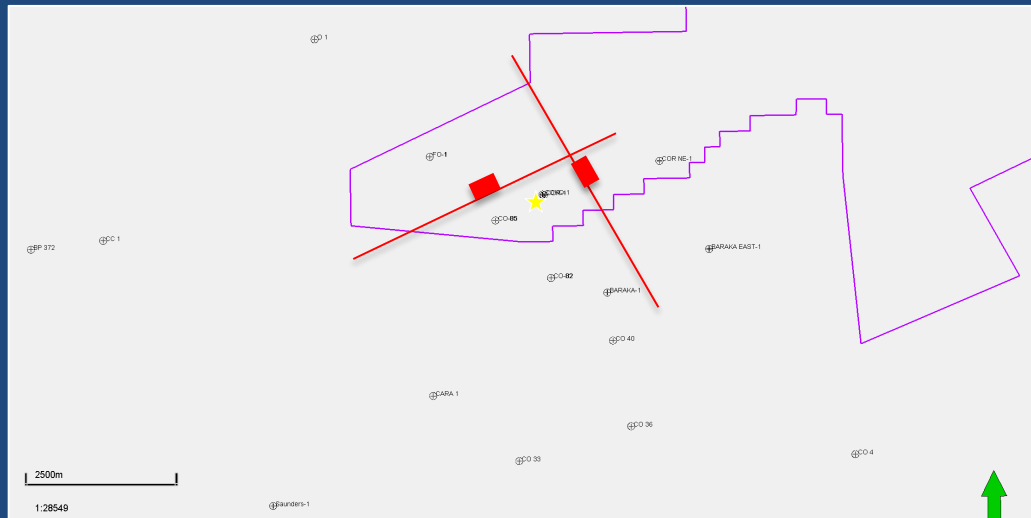
FO-1 (La Fortitude-1) was spud by Shell in April 1959, and drilled a normal succession, encountering the Gg7 Karamat at 5555, Top Herrera sandstones at 8155ft, with TD at 10705ft in Gr7d Herrera shales. Dips within the Karamat to Herrera interval all share a north westerly azimuth. No production



Shell's thinking at this time is that there is a large northward dipping SW-NE trending normal fault between CO-85 and FO-1



COR-1 (COROSAN-1) was spud by Vintage Petroleum (later Vermillion) in June 2001 using Well Services Rig 15. COR-1 drilled a normal succession encountering the Gg7 Karamat at 5147, Top Herrera sandstones at 5277ft, with TD at 7520ft within Gr7d Herrera shales.



Based on 2D Seismic Vintage saw an easterly dipping normal fault up-plunge of CO-85

Six DST's were performed.

Test 1 – 7093-7103 – flowed 98.2bbls water with gas

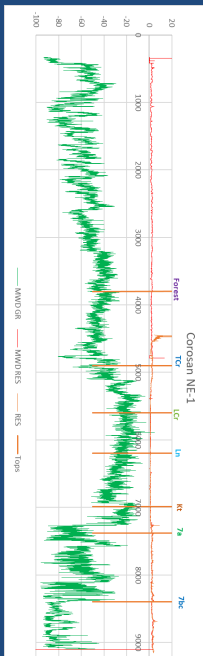
Test 2 – 5965-5975 – flowed 40bbls water with gas (15-20000ppm)

Test 3 – 5760-5768 – flowed 4.4mmcf on 20/64" at 2853psi with 385bbls water per day (15000ppm)

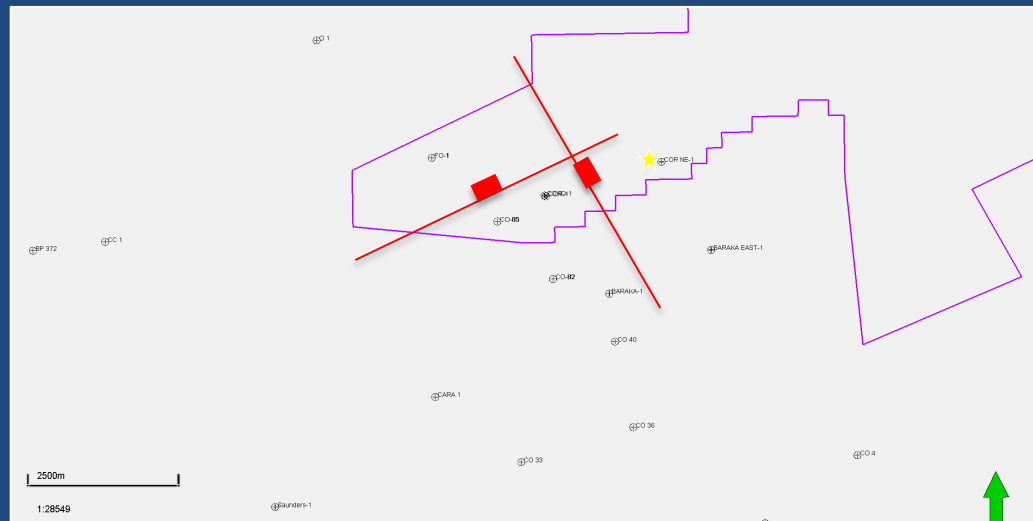
Test 4 – 5500-5516 – flowed 3.7mmcf on 20/64" at 2830psi with 300bbls water per day (15000ppm)

Test 5 – 5240-5252 – flowed 799bbls water on 20/64" at 1239psi (20000ppm)

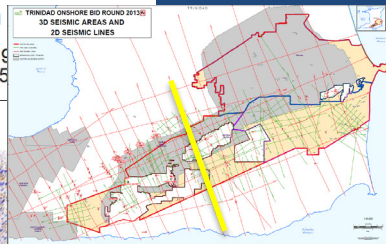
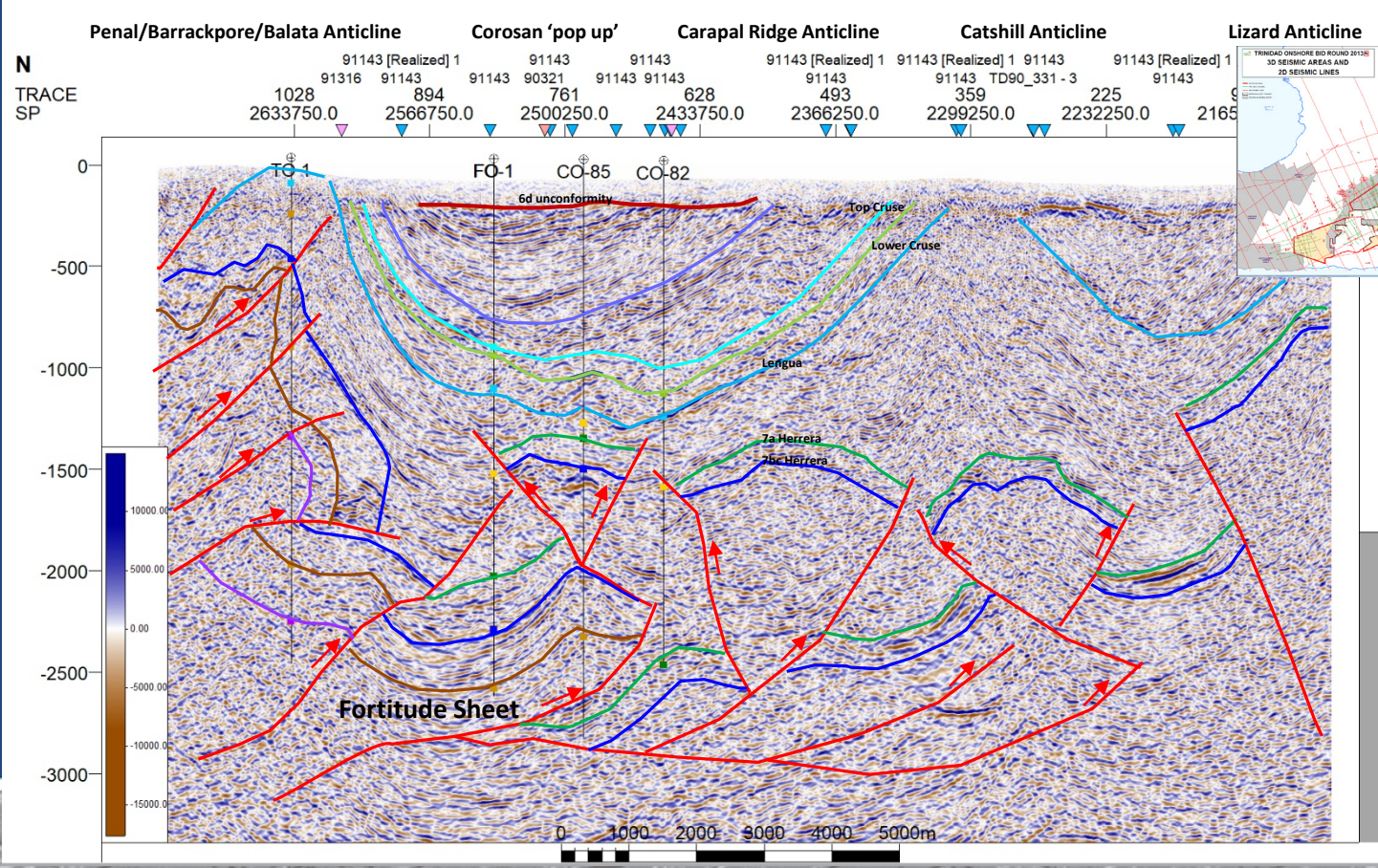
Test 6 – 5216-5226 – flowed 100bbls water in 5hrs on 20/64" at 603psi (15000ppm)



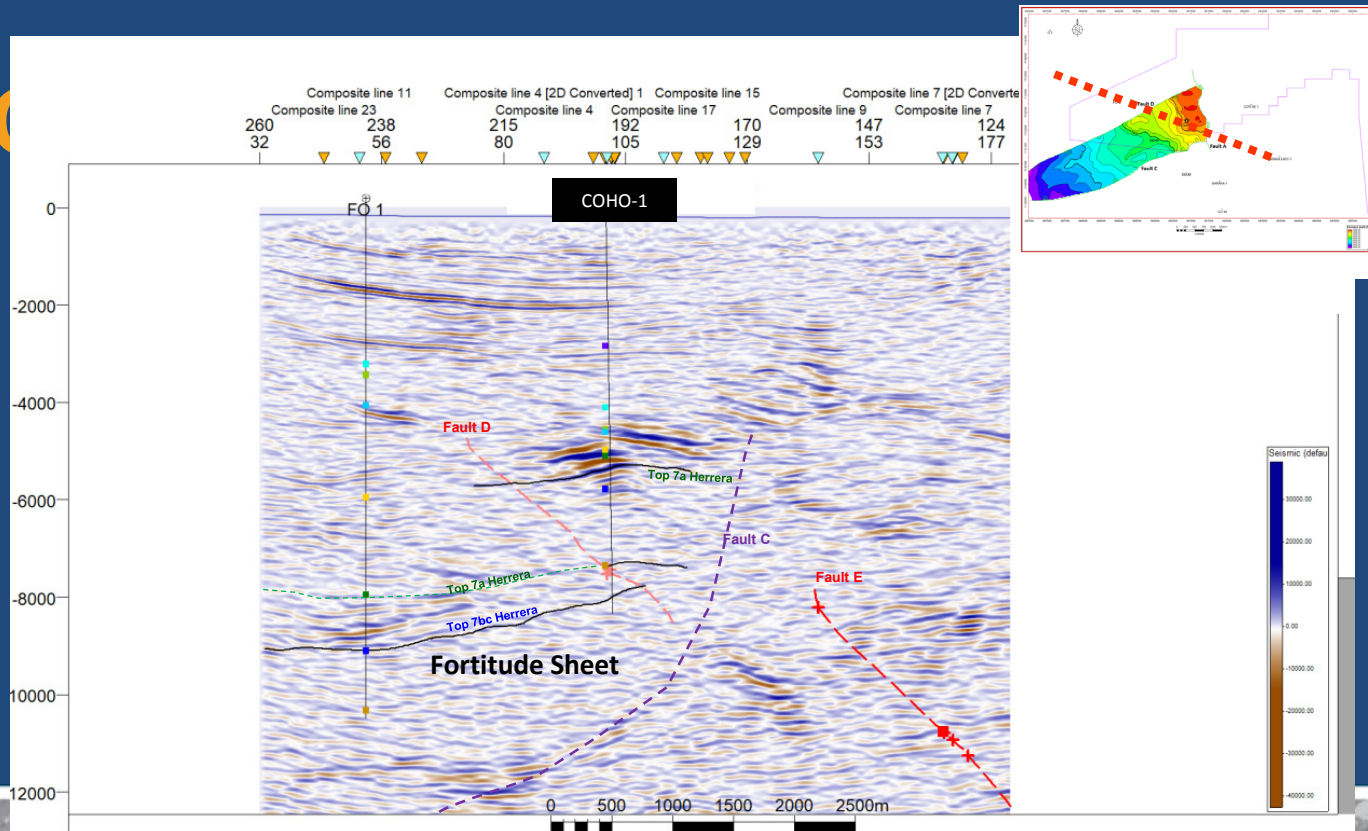
COR NE-1 (COROSAN NE-1) was spud by British Gas in January 2007 and drilled a normal succession encountering the Gg7 Karamat at 6990, Top Herrera sandstones at 7380ft, with TD at 9149ft still within the Herrera sandstones. No tests conducted. All sands were interpreted to be wet with residual hydrocarbons.

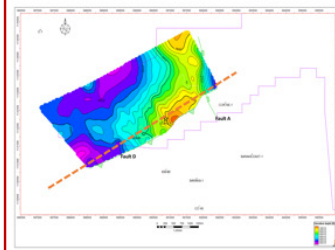
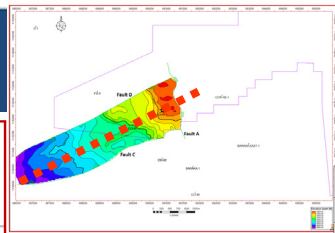
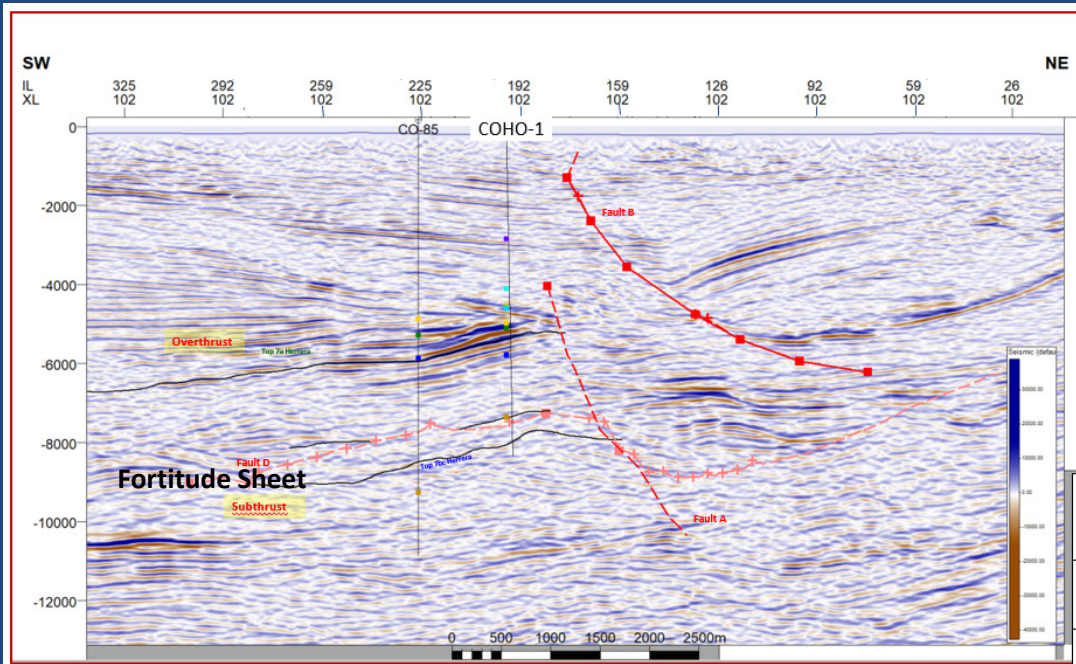


Based on 3D Seismic BGTT targeting the downthrown eastern hangingwall but unfortunately did not find a suitable trap



Relooping at the 2D seismic. TETL concept is a fold & thrust belt with localised 'pop up' structures. In each 'pop up' structure the underlying footwall either has not been drilled or has been drilled down plunge





TOUCHSTONE
EXPLORATION (TRINIDAD) LTD.

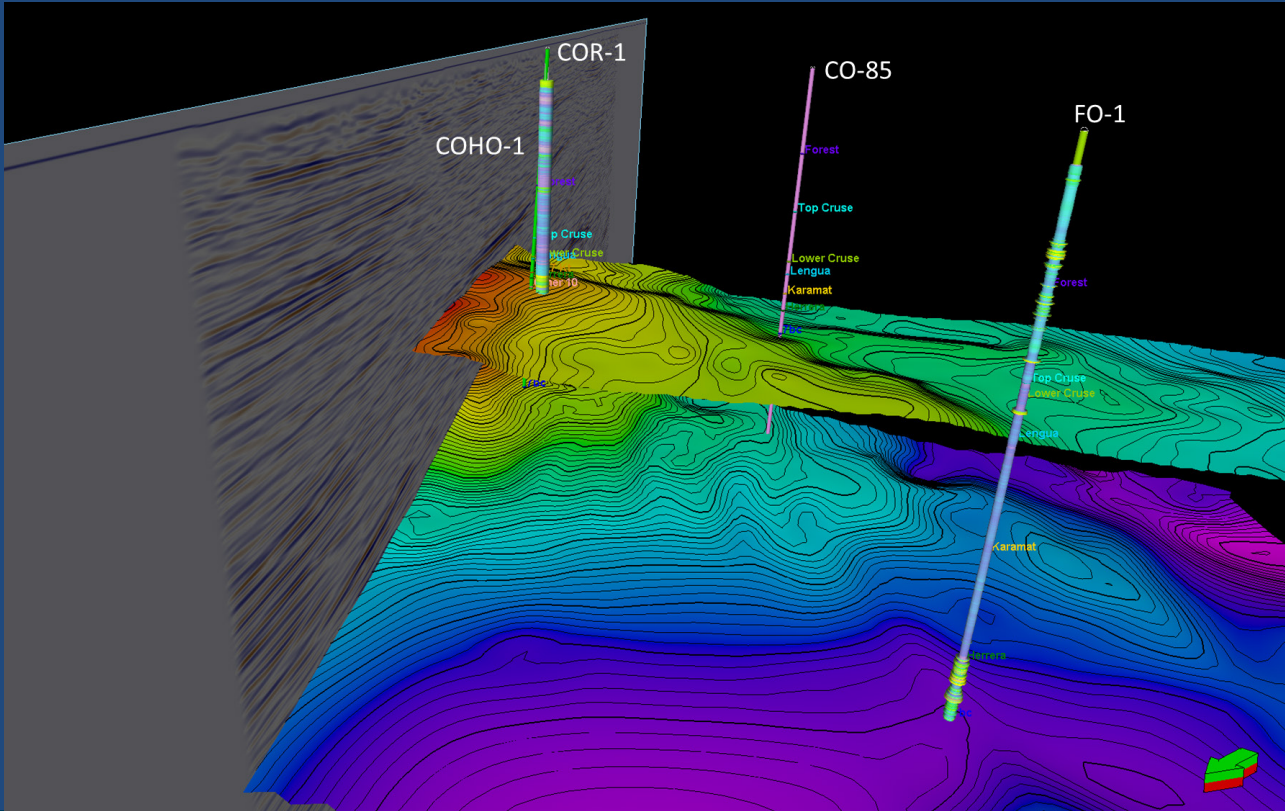
LOCATION: COHO-1
SEISMIC CROSS SECTION
ORTOIRE BLOCK

STRIKE

PREPARED BY X. MOONAN & C. MCLAREN
MARCH, 2019



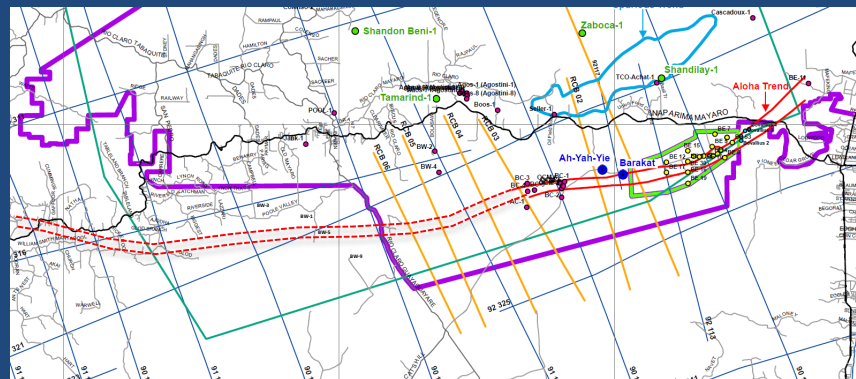
COHO-1 Perspective







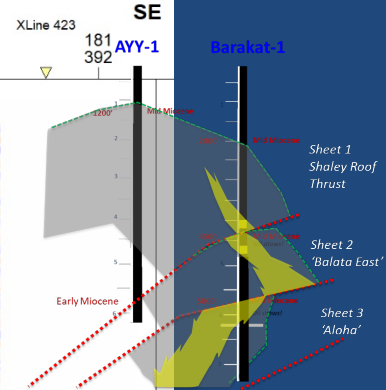
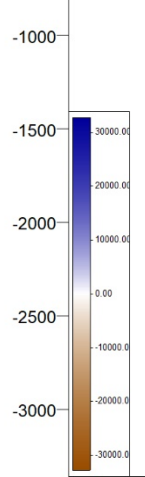
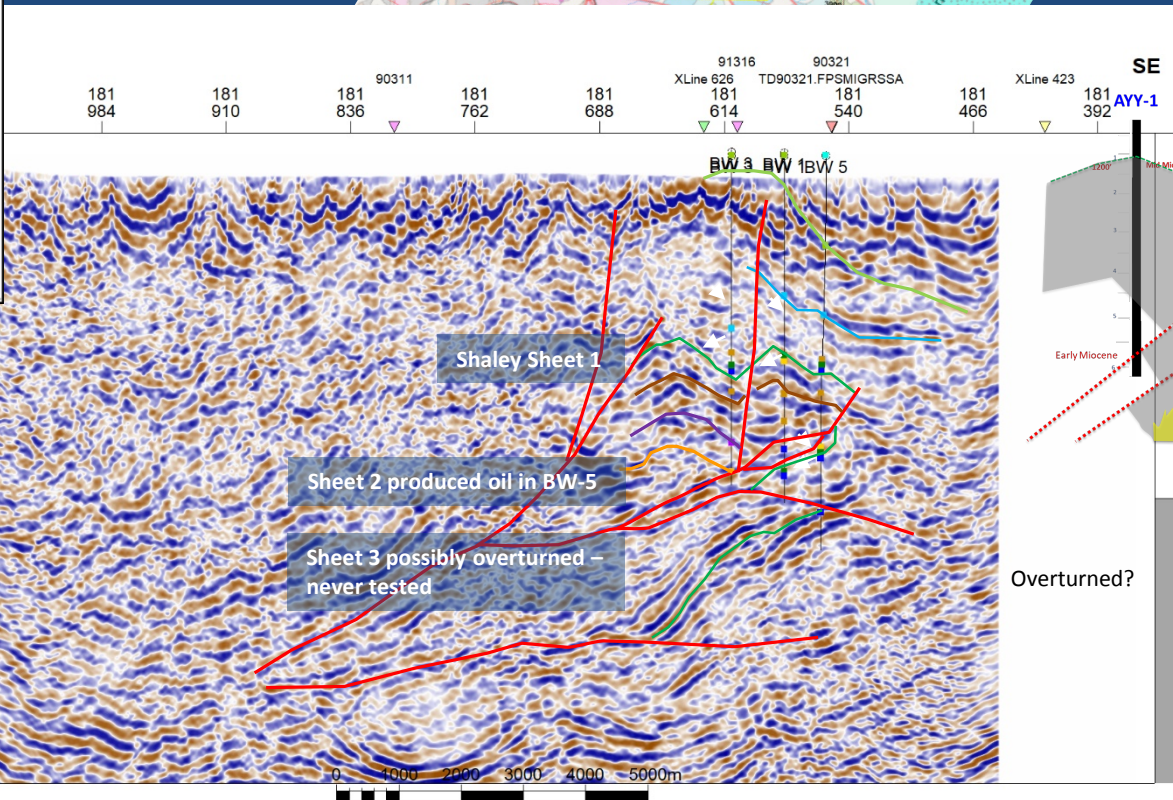
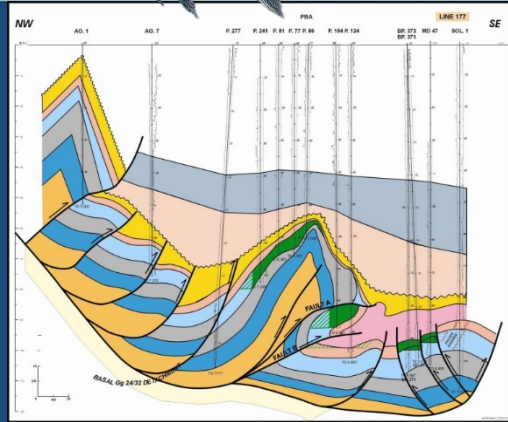
Cascadura CAS-1 2nd Exploration Well



TETL's CAS-1 is on trend with the Balata Anticline and the LOL's exploration well Barakat-1. Both companies evaluated their areas separately and came together to 'peer review' models and concepts. And interestingly both companies arrived at the same structural and depositional model.



Balata West Area



Overtured?

Why Explore an 'explored' basin?

- It is only 'as explored' based on when it was explored - the models were only as good as the data and mapping techniques available at the time.
- In areas with overprinting of multiple phases of deformation it is quite easy to 'miss' or mis-understand depositional fairways, trap geometry and sealing capacity.
- A determined, highly optimistic but pragmatic team is required to push ahead despite the surrounding failures
- Good things come to those that keep trying...new things..

Thank you!

