PS Insights into the Cretaceous Play Southern Basin, Trinidad

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Abstract

Late Maastrichtian marked the start of the drift phase and an end to the passive margin conditions that existed in the northwest trending, once progradational, Cretaceous shelf, where Trinidad's Southern Basin sat. The basin began experiencing rifting that resulted in the channelization of inner Cretaceous shelfal deposits that travelled axial parallel within the Espino Graben via rivers to be deposited as northward-facing Cretaceous turbidites. By Late Oligocene, the influence of the incoming Caribbean Plate resulting in a foredeep that plunged the Southern Basin further into deepwater territory, allowing for, in addition to the sediment source to the south coming from South America, sediments being shed off of the newly exhuming Cordillera de la Costa and Central Range to the northwest due to oblique collision. As the Caribbean plate continued its relative eastward motion, the Proto-Orinoco delta was deflected eastward, with turbidites being deposited in an asymmetric re-entrant, with the southern input becoming progressively less influential over time.

Across the current acreage spread that Touchstone Exploration holds onshore Trinidad, 4 keys wells stand out from the pre-existing dataset as having all been drilled in search of slope and basin-floor turbidite reservoirs of the Cretaceous, namely the Naparima Hill, Gautier and Cuche formations, as their primary targets. These wells are the Iguana River-1 and the Ste Croix-1 wells drilled by Exxon and partners of the Southern Basin Consortium in 1993 and 1995 respectively, and the Zaboca-1 and Shadon Beni-1 wells drilled in 2005.

In addition to historic well reports inherited for these wells, rock samples, either dry or wet, were retrieved from the Ministry of Energy and Energy Industries' core repository and sent for biostratigraphic analysis to review and confirm the findings of inherited palaeontological reports that would have determined the respective rock formation encountered throughout the well by age, but also to make conclusive determination of the depositional setting of the rocks using key foraminiferal markers. This report serves to present the findings of the updated biostratigraphic analysis of each of these wells and the overall implications on our pre-existing interpretation of the Southern Basin palaeoecology.

References:

Elrich, R.N., and J. Keens-Dumas, 2007, Caribbean Exploration – Planning for the Next Century: GSTT, 4th Geological Conference.

Kugler, H., 1961, Geological Map and Sections of Trinidad (1:100,000): Orell Fussli, Zurich, Switzerland.

Ramlackhansingh, A. & Bruce Eggertson, B., 2007, Seismic Expression and Interpretation of Structures and Depositional Setting in The Greater Trinidad Region, Transactions of the 4th Geological conference of the GSTT.

Ramlackhansingh, A., 2007, Tectonostratigraphic evolution of the Greater Trinidad Area (onshore and offshore): Exploration & Geophysics Group, Petrotrin Internal Report. Pindell, J., and K. Lorcan, 2005, Paleogeographic Mapping and Documentation of Sandstones/Reservoir Systems, Palaeogene to mid-Miocene of Trinidad and Eastern Venezuela.

INSIGHTS INTO THE CRETACEOUS PLAY SOUTHERN BASIN, TRINIDAD

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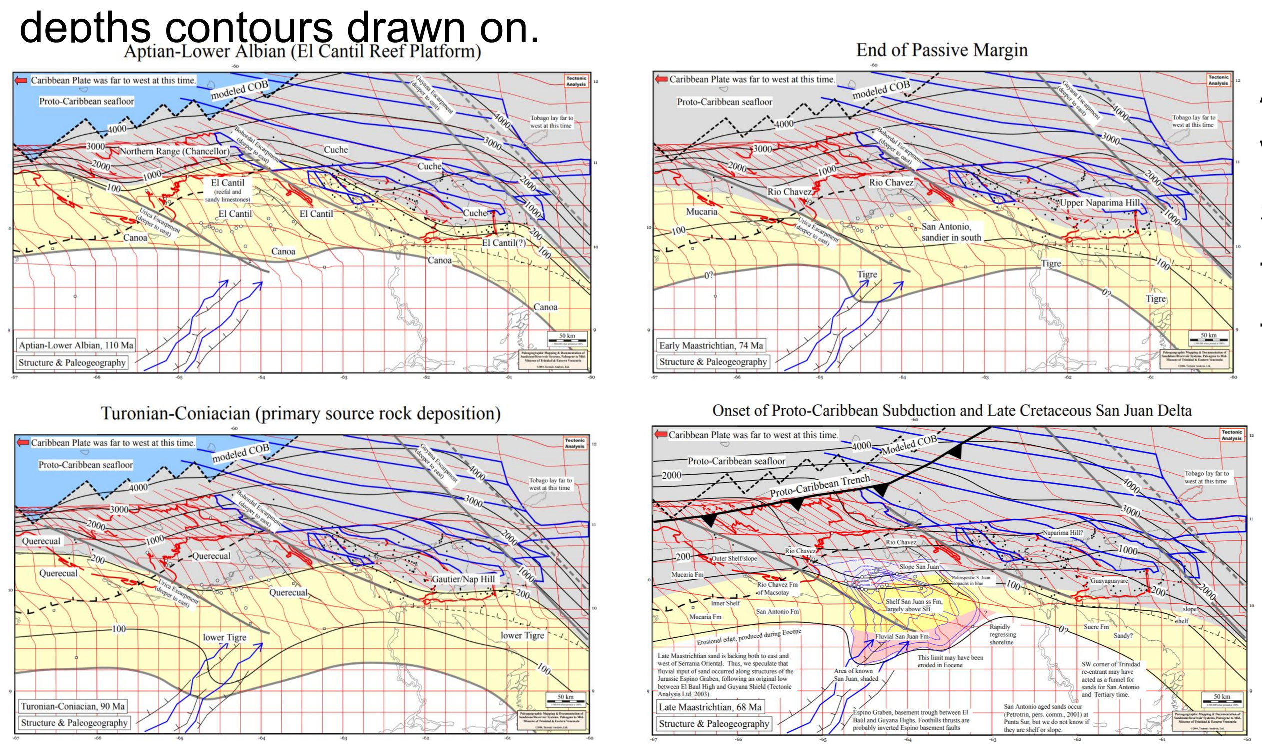
The Cretaceous play refers to conventional sand-rich turbidites encased in pelagic shales, laterally charged by interbedded source rock and trapped by either or both structural and stratigraphic traps. In Guyana and Suriname, it consists of undeformed deep water fans occurring as stratigraphic pinchouts and compactional traps due to structural drape. In Trinidad, the tectonic activity since deposition of our Cretaceous rocks, in addition to the later deltaic sedimentation and loading, has resulted in our rocks undergoing multiple stages of deformation that has impacted trap integrity and preservation of porosity/permeability. Refining what is known about Cretaceous penetrations can aid in derisking uncertainty, generating opportunities for exploration across Trinidad's basins.

According to Ramlackhansingh (2007), the drilling of the 3 Southern Basin Consortium (SBC) wells located within the Present Day Onshore Southern Piggyback Basin-Southern Range Anticline penetrated siliciclastic deepwater basin floor sandstone units with associated confined channel levee complex which reflect north facing basin floor fan lobes that young from east to west, i.e. Aptian/Albian- Cuche lobe in the east (Iguana River -1), Albian-Cenomanian lobe to the west of it (ME-15) and Campanian-Turonian lobes just to the west (Rocky Palace-1/MDB-34/St. Croix-1). Lobe sizes average 20km in width and 20km in length. Basin floor fan sediments being point source derived from deltaic settings located in the shelfal setting to the south towards the Guyana Shield composed of arkose to sub-arkose sandstones derived from the disintegration of the Guyana Shield granitic rocks including high grade feldspathic gneiss and schists.

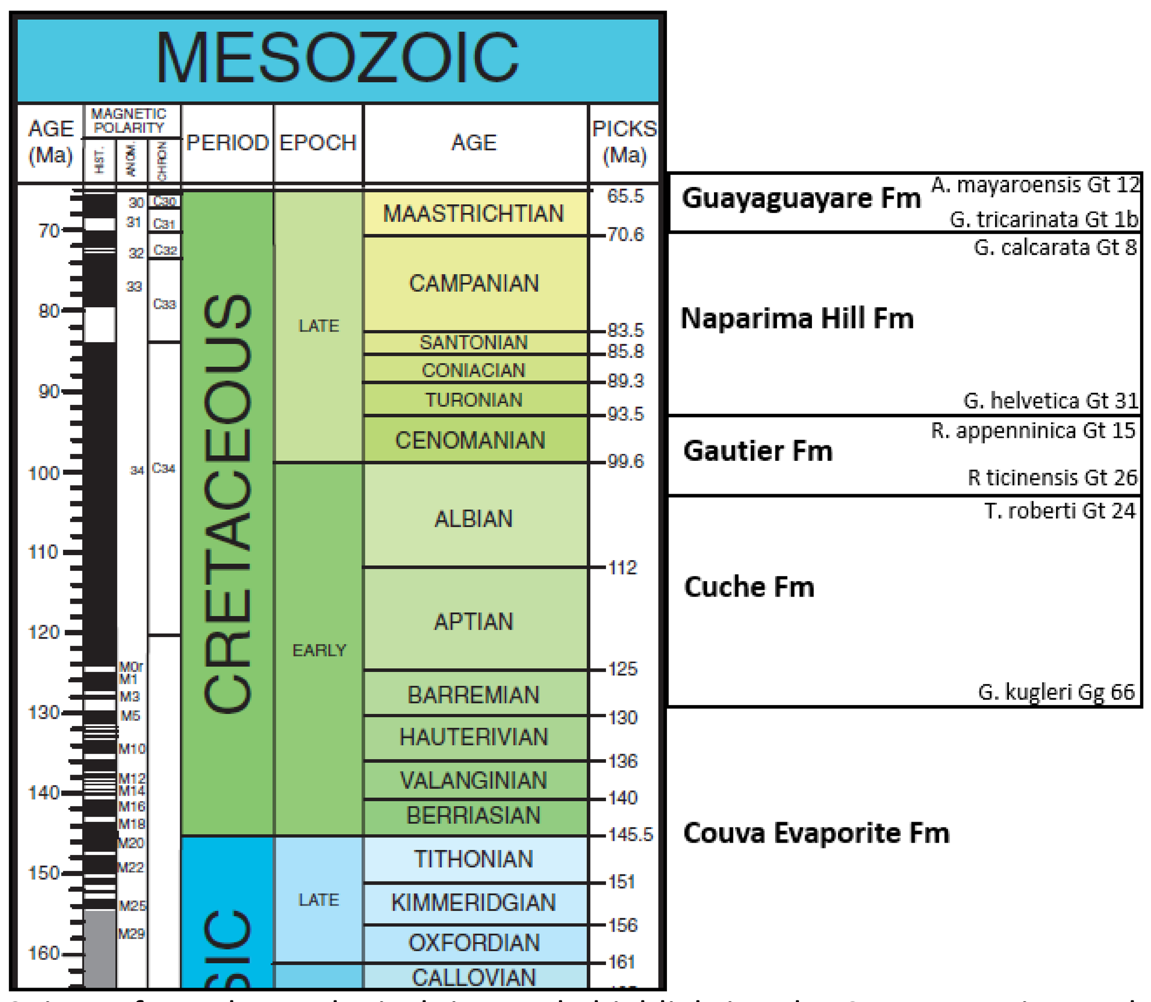
Work by J.Pindell et al. (2004) resulted palinspastic maps from Jurassic time to 2 mya, with quasi-hypothetical water depths contours drawn on.



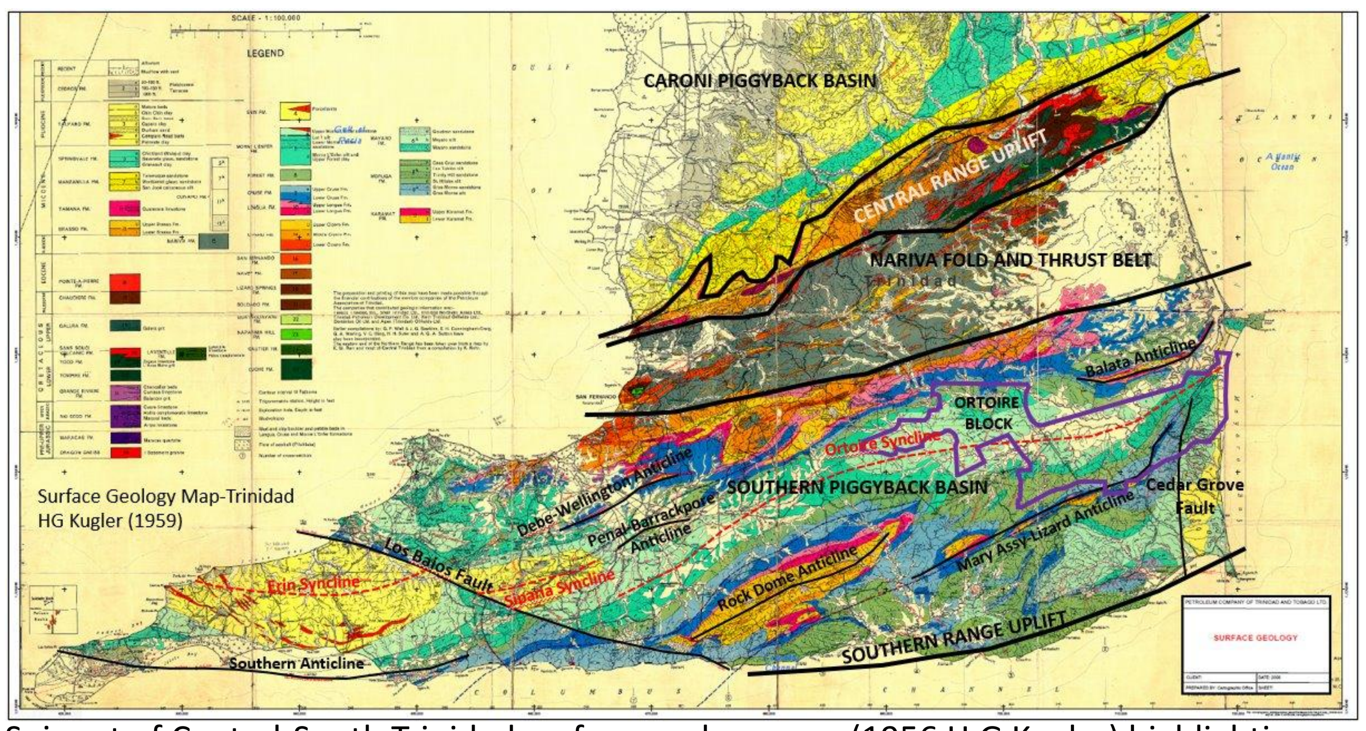
A NE-ENE direction of gradual deepening of the wider continental shelf is reflected, with consistent shelf location and water depth contours from Cuche to Guayaguayare, ie the entirety of Cretaceous, with the Southern Basin existing within water depths of 100-1000m.

Revised palaeontological work on 4 key wells, namely Iguana River-1, Ste Croix-1, Zaboca-1 and Shandon Beni-1, within the Southern Basin has revealed quantitative control points to the contours displayed on these maps via palaeobathymetry.

DRIFT (~157Ma-65Ma) (~Cretaceous)



Snippet from the geological timescale highlighting the Cretaceous interval and formations deposited in Southern Basin during that time.



Snippet of Central-South Trinidad surface geology map (1956 H.G Kuglar) highlighting key geological feature.

ST CROIX 1

STE CROIX 1						
Interval (ftMD)	Age	Formation	Lithology	Palaeoenvironment	Bathymetry (m)	Depositional Environment Interpreted
13595-13600	Maastrichtia		Claystone, siltstone	Mid Bathyal-Lower Bathyal	500-2000	Continental slope-mid
13600-13610			Claystone, Limestone, sandstone			
13640-13650			Claystone			
13730-13740	Campanian	Naparima Hill	Limestone	Lower Bathyal	1000-2000	Continental slope-base
13960-13970			Claystone,			
14040-14050			Sandstone			
14120-14130			Sandstone, claystone, siltstone			
14210-14220			Claystone, siltstone, sandstone	Upper Bathyal	100-500	Distal continental shelf-edge of shelf
14220-14230	Santonian			Inconclusive		
14580-14590						
14590-14600	Coniacian					
14740-14750				Outer Neritic-Upper Bathyal		
14750-14760	Turonian			Inconclusive		
14960-14970						
14970-14980	Cenomania			Outer Neritic		
16000-16010			Claystone, shale	Lower Bathyal	1000-2000	Continental slope-base
16010-16020	Late Albian	Gautier	Claystone, shale, limestone			
16560-16570			Claystone, trace sandstone	Inconclusive		
16570-16580		Cuche		Lower Bathyal		
16650-16660				Inconclusive		
16660-16670						
16880-16890						
16890-16900						
16940-16950						
16950-16960						
16980-16990				Outer Neritic-Upper Bathyal	100-500	Distal continental shelf-edge of slope
17540-17550			Claystone, shale, limestone	Inconclusive		
17550-17560						
17580-17590			Claystone,			

- Reviewed existing biostratigraphic tops
- Re-examined 300 dry mudlogging samples. These samples were very small, bringing a greater level of uncertainty to the biostratigraphy interpretation.
- 29 samples were processed and picked for analysis between the interval 13595'-17590'MD. Recovery of fauna ranged from very poor (<10 species) to good (<50 species).
- An overall sea level rise is noted across the Cretaceous.
- New biostratigraphic findings reflect Outer Neritic environment amongst Lower Bathyal conditions. This can be attributed to turbidites.
- The Cuche shows a gradual drowning from distal continental shelf to base of slope environment; it is apparent from the early limestone occurrence that reefal settings persisted on the shelf setting, and with trace amounts of sandstone occurring as sea level was rising, we can deduce that sand was being bypassed at this location into the abyssal plain further to the north and east.
- The same transgression pattern was noted in the Naparima Hill after the Cenomanian-Turonian event, but the continental shelf and slope saw more sand deposition than previous transgression, therefore having greater reservoir potential.

IGUANA RIVER 1

IGUANA RIVER 1						
Interval (ftMD)	Age	Formation	Lithology	Palaeoenvironment	Bathymetry (m)	Depositional Environment Determined
5280-5310		Cipero (Gg 32)	Claystone, siltstone, lignite	Mid Neritic-Outer Neritic	50-200	Prodelta into open continental shelf
5310-5340			Claystone, siltstone			
5340-5370	Early Miocene			Outer Neritic	100-200	Distal continental shelf-edge of slope
5370-5400	Inconclusive		Argillite	Mid Neritic-Outer Neritic	50-200	Continental shelf-Intermediate to edge of shelf
5400-5410		Naparima Hill		Mid Bathyal-Lower Bathyal	500-2000	Continental slope-mid
5420-5430						
5430-5440						
5440-5450						
6780-6790	Early Santonian		Chert and argillite	Outer Neritic-Upper Bathyal	100-500	Distal continental shelf-edge of shelf
6790-6800						
6800-6810			Argillite			
7000-7010			Shale, claystone,			
7050-7060			Siltstone, argillite,			
7470-7480			Claystone, argillite			
7490-7500						
7500-7510						
7510-7520						
7980-7990	Coniacian		Claystone			
8000-8010	Turonian					
8020-8030						
8590-8600	Cenomanian	Gautier	Shale, sandstone	Outer Neritic	100-200	Distal continental shelf
8600-8610	Late Albian					
8840-8850						
9810-9830			Shale, sandstone, siltstone			
9910-9930		Cuche		Mid Neritic-Outer Neritic	50-200	Prodelta into open continental shelf
9930-9950						
9950-9960						
9980-9990						
10120-10130						
10130-10140						

- Reviewed existing biostratigraphic tops
- Re-examined 74 dry mudlogging samples (all containing less than 20cc of sample)
- 30 samples were processed and picked for analysis between the interval 5280'-10140'MD. Recovery of fauna ranged from very poor (<10 species) to good (<50 species).
- Iguana River-1 well shows sea level rise across the Cretaceous.
- The lithologies and the palaeoenvironment data for the Cuche and Gautier reflect good deposition of siliciclastics on the edge of the prodelta and open continental shelf to the distal continental shelf respectively.
- Non-deposition of reservoir for the Naparima is attributed to the area either being too distal on the continental shelf where sediments did not favourably pool either due to oceanic paleocurrents or due to the existence of canyons that aggressively convulse backwards into the shelf from the slope creating constant instability that is not favourable for sediment pooling, or the existence of bypass channels that transport gravity-driven sediments further to the north and east.

ZABOCA 1

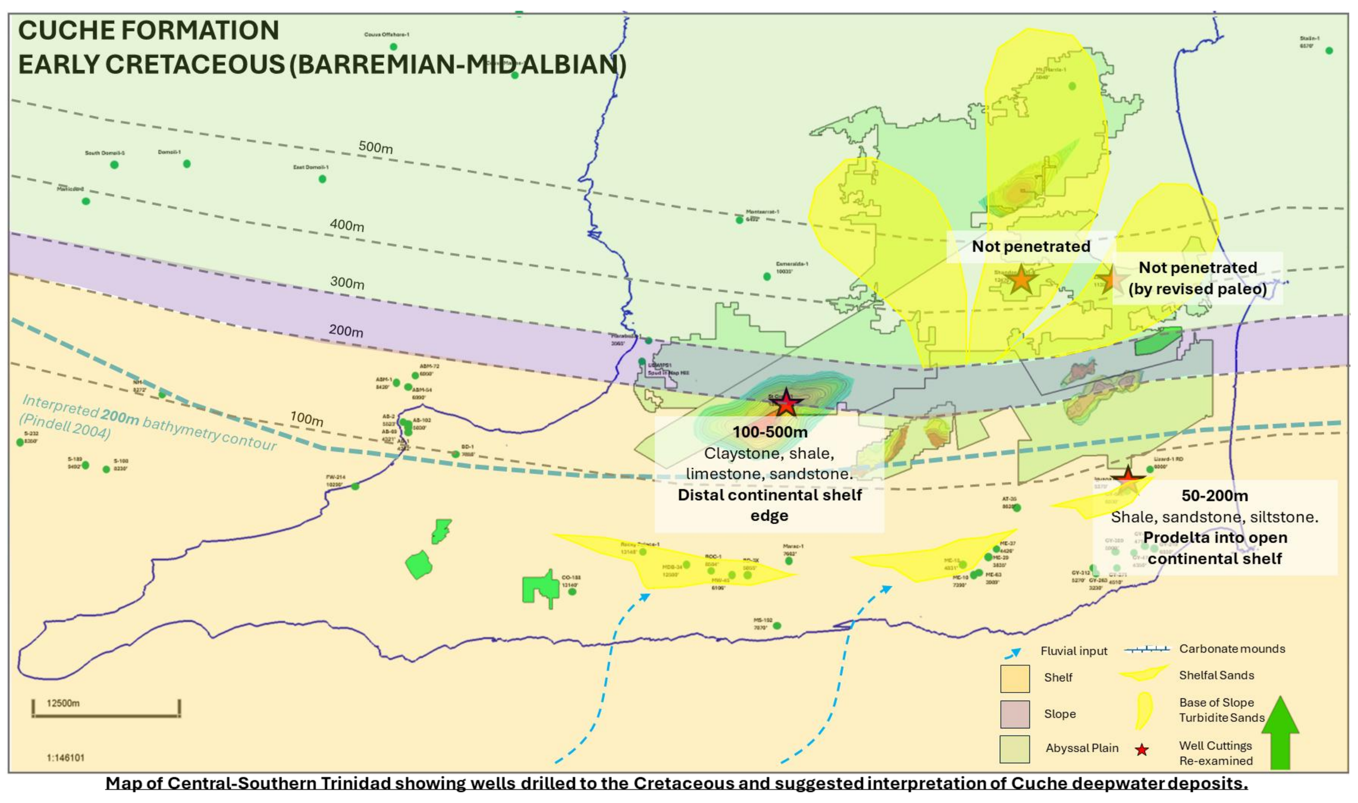
ZABOCA 1						
Interval (ftMD)	Age	Formation	Lithology	Palaeoenvironment	Bathymetry (m)	Depositional environment interpreted
9930-11480	Oligocene	Nariva/ Cipero	Claystone, siltstone, sandstone	Outer Neritic to Upper Bathyal	100-500	Distal continental shelf-edge of shelf
11480-11670	Turonian	Naparima Hill	Claystone, shale	Upper bathyal	200-500	Edge of shelf
11670-13450	Cenomanian	Gautier	Shale, claystone, limestone, marl, anhydrite, trace sandstone	Outer Neritic to Upper Bathyal	100-500	Distal continental shelf-edge of shelf

- Reviewed existing biostratigraphic tops
- Re-examined wet mudlogging samples
- 38 samples were processed and picked for analysis between the interval 9930'-13450'MD. Recovery of fauna ranged from very poor (<10 species) to good (<50 species).
- Trace sandstone was noted in the Gautier section of the well, reflecting the area being near to but not exactly in a favourable location for deposition of reservoir.

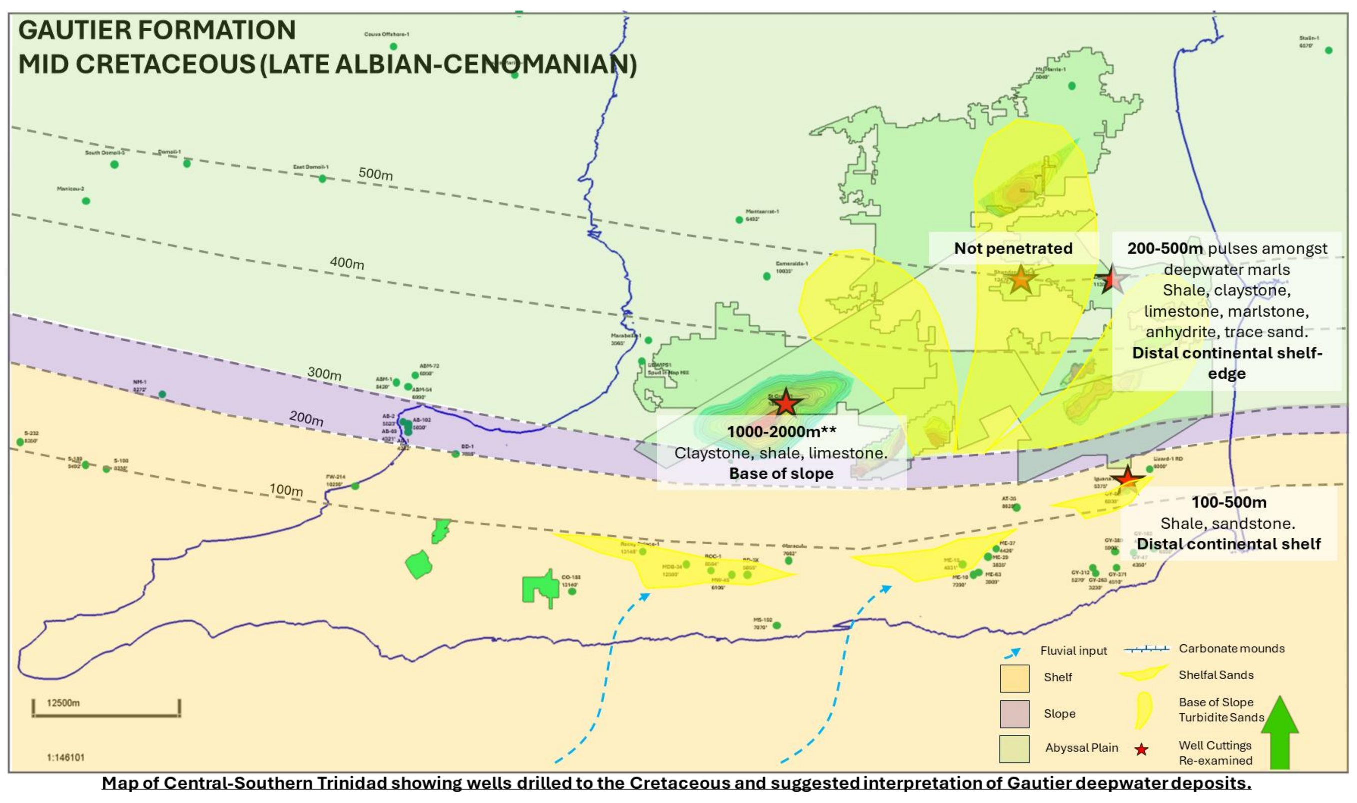
SHANDON BENI 1ST2

SHANDON BENI 1ST2						
Interval (ftMD)	Age	Formation	Lithology	Palaeoenvironment	Bathymetry (m)	Depositional environment interpreted
12490-12590	Maastrichtian-Guayaguayare	Guayaguayare	Mudstone/Claystone, marlstone, limestone	Upper bathyal	200-500	Edge of shelf
12590-12830	Paleocene	Lower Lizard Springs	Claystone, limestone, marlstone, chert, sandstone			Distal continental shelf-Slope
12880-14610	Eocene	Upper Lizard Springs	Mudstone, limestone, sandstone, marlstone			Distal continental shelf-Slope

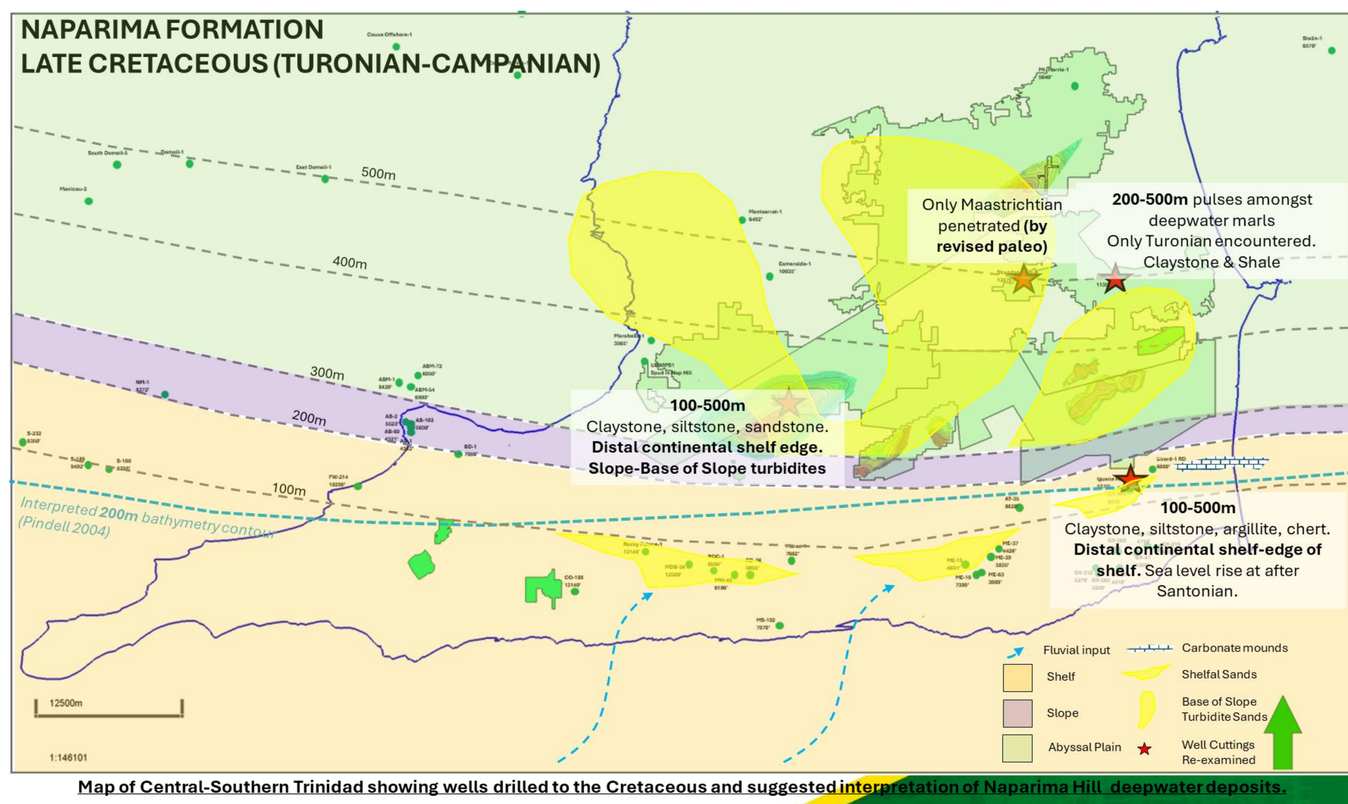
- Reviewed existing biostratigraphic tops
- Re-examined wet mudlogging samples
- 24 samples were processed and picked for analysis between the interval 12490'-14610'MD. Recovery of fauna ranged from very poor (<10 species) to good (<50 species).
- The revised biostratigraphy reveals that only Guayaguayare, ie Late Cretaceous, was intersected by this well. This reflected a palaeoenvironment of Upper bathyal setting. Note, the previous Naparima Hill determination was made off of the lithology and not biostratigraphy.
- Due to poor faunal preservation in samples, as well as the high amount of contamination of samples from cavings during the drilling of the well, the biostratigraphic determinations were made with a reduced amount of certainty.



Map of Central-Southern Trinidad showing wells drilled to the Cretaceous and suggested interpretation of Cuche deepwater deposits.



Map of Central-Southern Trinidad showing wells drilled to the Cretaceous and suggested interpretation of Gautier deepwater deposits.



Map of Central-Southern Trinidad showing wells drilled to the Cretaceous and suggested interpretation of Naparima Hill deepwater deposits.

References:

Elrich, R.N., and J. Keens-Dumas, 2007, Caribbean Exploration – Planning for the Next Century: GSTT, 4th Geological Conference.

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