A New Look at the Petroleum System within the S-659 Area, Soldado North, Gulf of Paria*

Shazana Gazalie[1] and Karuna Moonan[1]

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[1]The Petroleum Company of Trinidad and Tobago Limited, Pointe-a-Pierre, Trinidad and Tobago (shazana.gazalie@petrotrin.com)

Abstract

Soldado North Field is considered the westernmost extent of the Nariva fold belt and offshore equivalent of the Central Range, within the Gulf of Paria pull-a-part basin. This structural complexity coupled with poor seismic quality may be responsible for the failure of the S-659 well to encounter commercial hydrocarbons. Petrotrin has recognized that the legacy 1992 seismic dataset has long downplayed the hydrocarbon potential of the Northern Basin sediments within the Soldado North Field. This research presents a detailed assessment and model from the GXT fast track dataset of the 2014 Trinmar OBC, which reveals a marked increase in prospectivity and new geophysical leads, identified within the westernmost Soldado North Field. One such lead, a characteristic flat spot, a direct hydrocarbon indicator (DHI) within the S-659 area, was targeted in this study to determine the hydrocarbon potential of the Miocene-Pleistocene reservoirs. An integrated approach to the study area, including seismic interpretation, attribute analysis, biostratigraphic evaluation and a geochemical review, was undertaken in an effort to better understand the reservoir. A combination of modern analogs contributes to the re-assessment of commercial hydrocarbon potential. Overall, the updated and detailed structural and biochronostratigraphic models for the area highlight the importance of well placement, explain the absence of hydrocarbons in the S-659 area, and further identify numerous prospective exploration plays within the structure.

References Cited

Carr-Brown, B., and J. Frampton, 1979, An outline of the stratigraphy of Trinidad: 4th Latin Amer. Geol. Congr., Field Guide, p. 7-19.

Germeraad, J.H., C.A. Hopping, and J. Muller, 1968, Palynology of Tertiary sediments from tropical areas: Review of Palaeobotany and Palynology, v. 6, p. 189-348.

Rull, V., 1997, Oligo-Miocene palynology of the Rio Chama Sequence (Western Venezuela), with comments on fossil assemblages as paleoenvironmental indicators: Palynology, v. 21, p. 213–229.

Telford, W.M., L.P. Geldart, and R.E. Sheriff, 1990, Applied Geophysics, second edition: Cambridge, Cambridge University Press, 770 p.

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Shazana Gazalie & Karuna Moonan ,

Petroleum Company of Trinidad and Tobago Limited

Petrotrin

Exploring Frontiers in a Competitive Environment

Outline

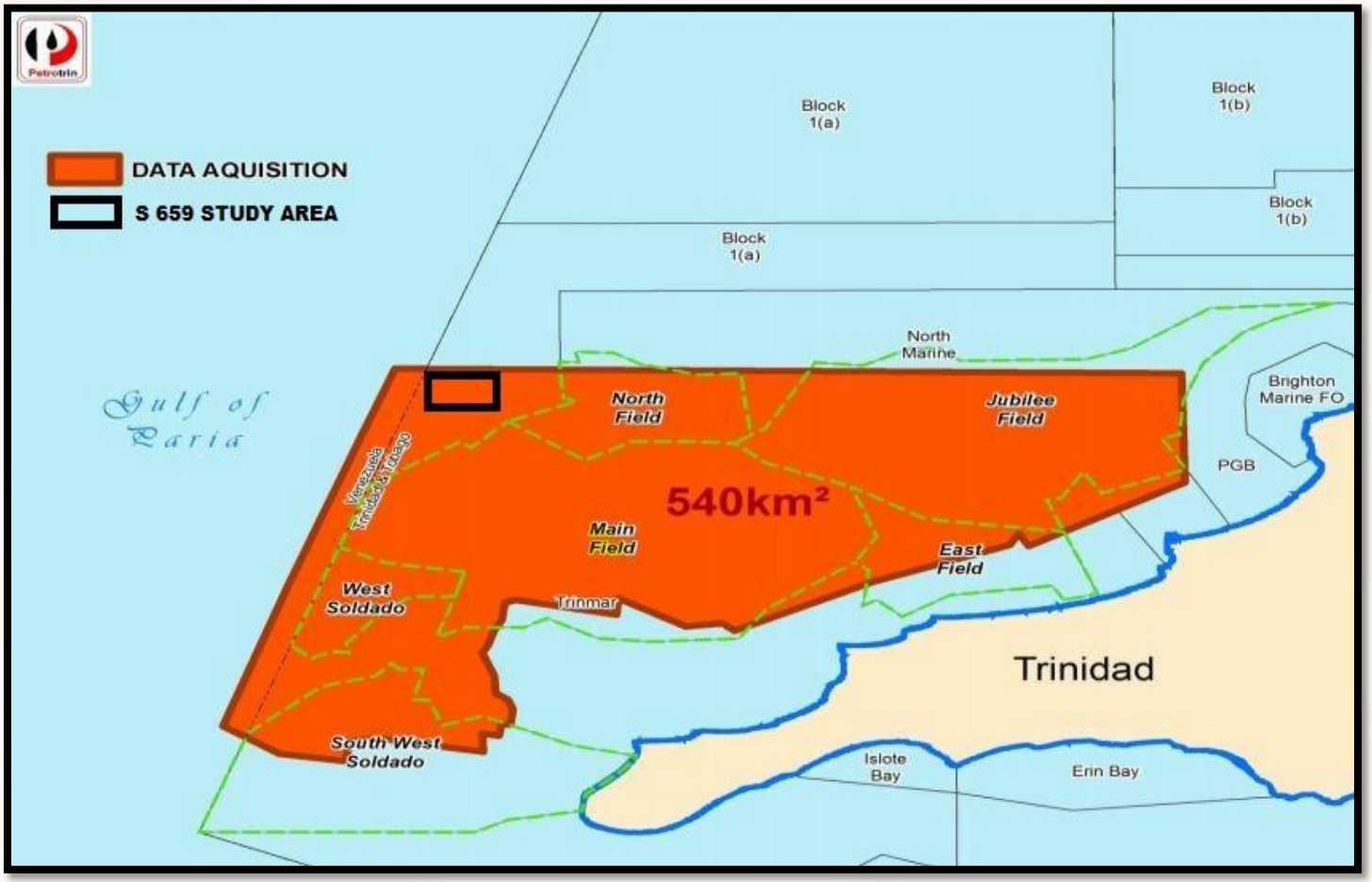
- Background – Objectives , Location, Regional Tectonic Framework
- **THEN** – Gaps in understanding Petroleum System
- **NOW** – Integrated multidiscipline studies tied with structural models
- Exploration Opportunities
- Conclusions
- Future Work
- References

Objectives

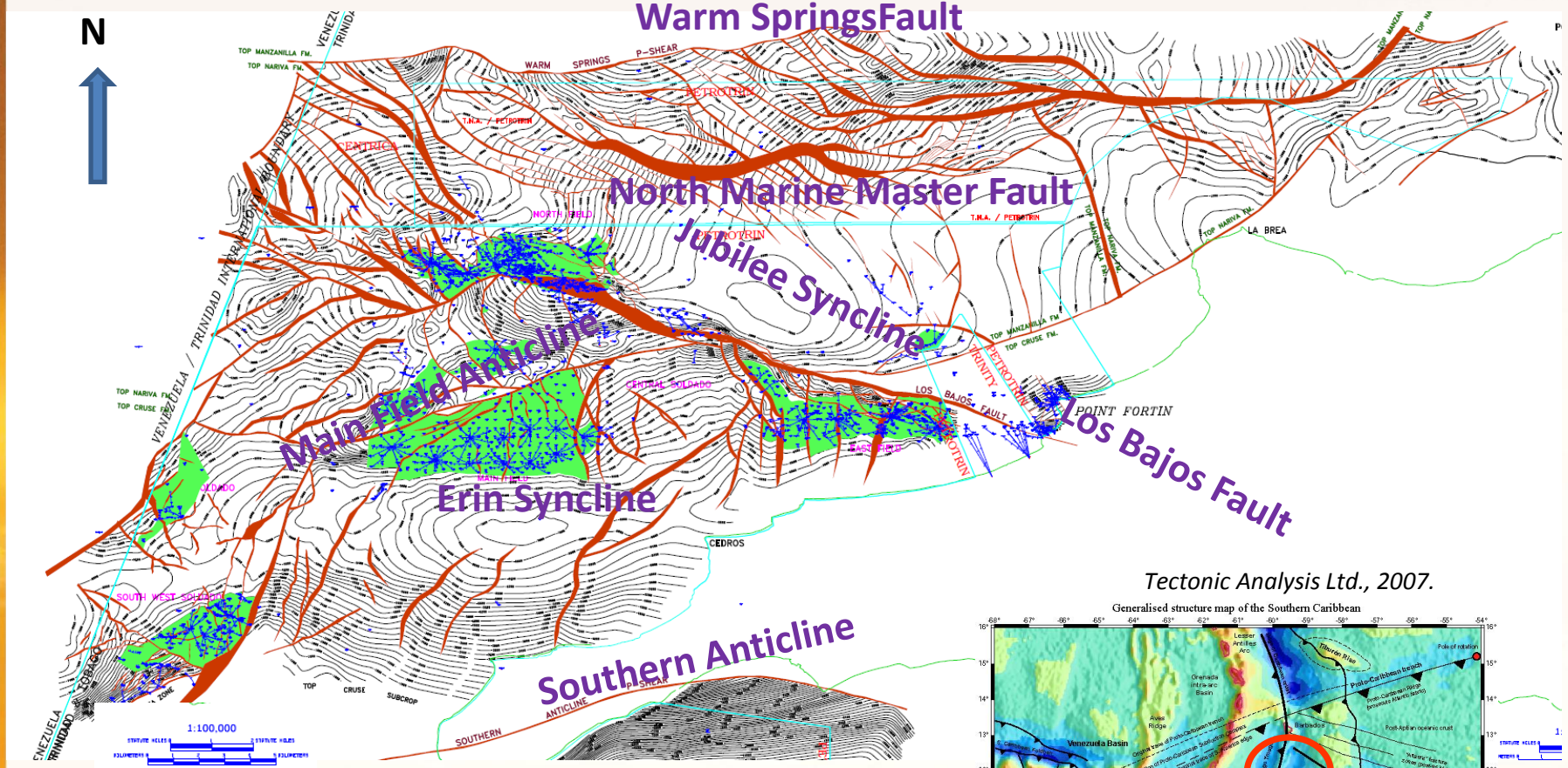
- Re-evaluate the S 659 successive unproductive sediments.
- Examine the high resolution biostratigraphy dataset for S-659 and surrounding wells.
- Further develop a stratigraphic feature identified in the Miocene-Pleistocene reservoirs in the GXT fast track dataset.
- Understand the petroleum system play in the S 659 Area.

Study Area

The S-659 Area is located west of the North Field and South West of Petrotrin's North Marine area.



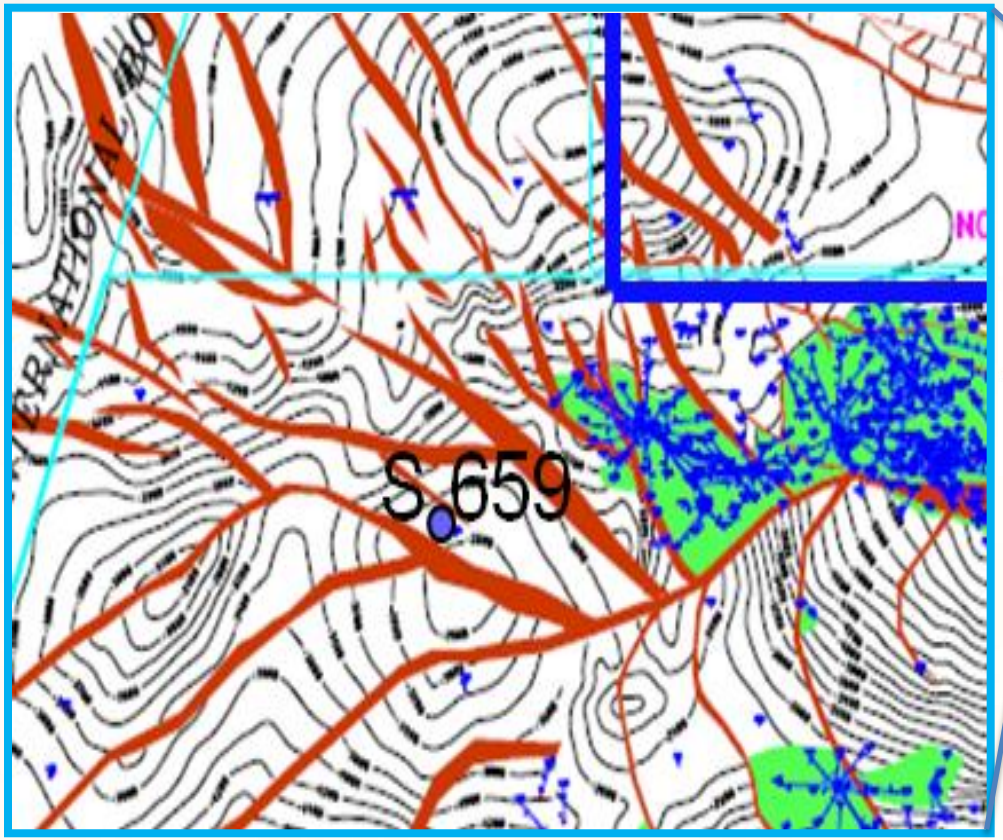
Regional Geology

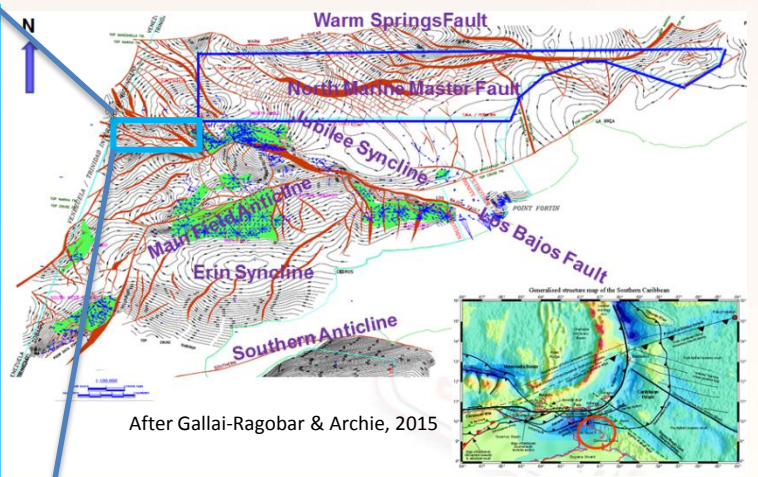


Gallai-Ragobar & Archie, 2015.

Tectonic Analysis Ltd., 2007.

Structural Framework





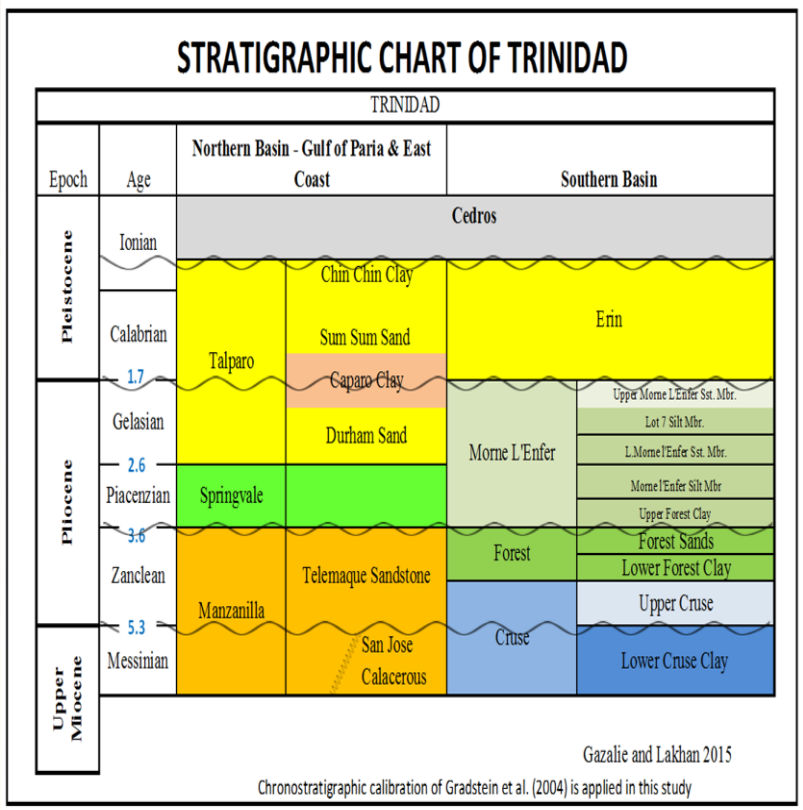
After Gallai-Ragobar & Archie, 2015

Tectonic Analysis Ltd., 2007.

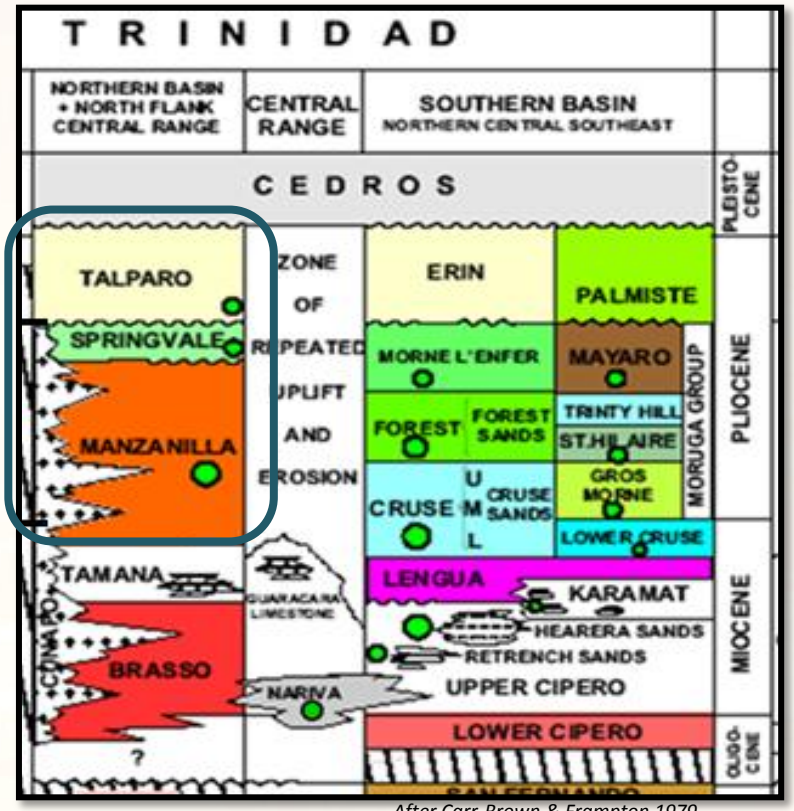
Faulting within the study area is characteristic of the strike-slip structural setting in the greater Gulf of Paria. Both compressional and extensional regimes are influential and can occur in a single fault zone.

Regional Stratigraphy

Revised stratigraphic chart was applied.



Traditional interpretations applied to basins.

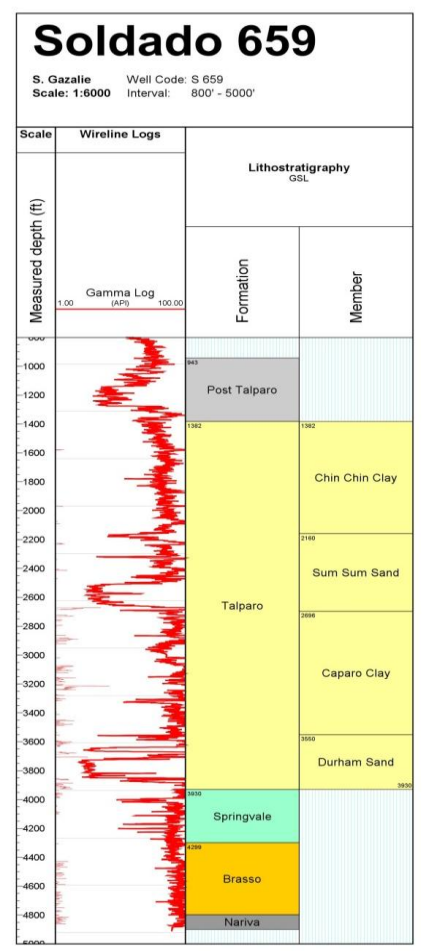


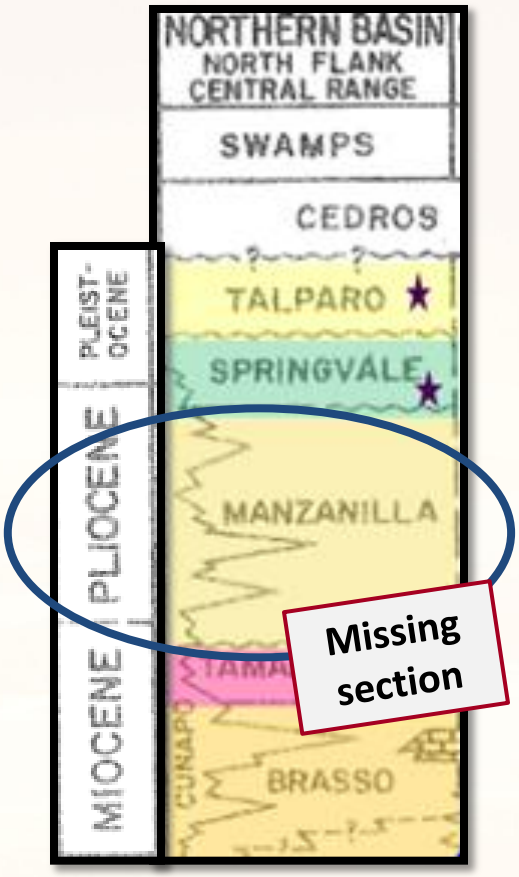
After Carr-Brown & Frampton 1979

The geologic Formations and their Members on the revised Stratigraphic Chart were characterised based on lithological and biostratigraphic fauna.

Stratigraphy

- Spudded in 1988
- Sands wet ; Sum Sum and Durham sand packages are well developed.
- Objective sands, Springvale – not well developed and wet.
- Springvale rested unconformably on Brasso sands, Manzanilla sediments not present.





Key well that contains paleo and checkshot data.

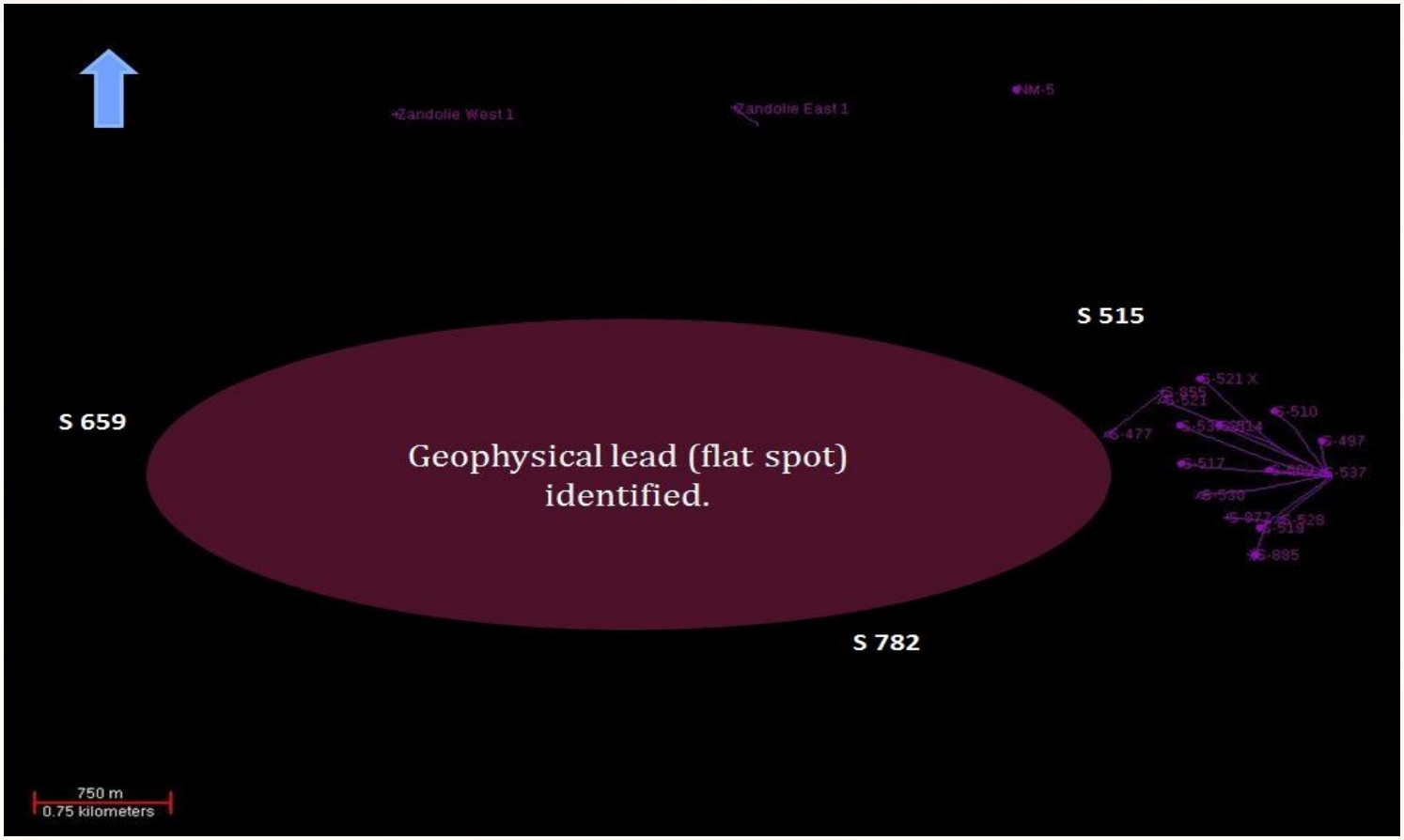
Production History

In the North Soldado field the most prolific reservoirs are found in the Manzanilla Formation. Sand thickness intervals varies from 10 feet to 400 feet.

WELL	CUM PROD mstb
S 659	0
S 477	0
S 782	0
S 515	0
S 530	115.3 (Manz)
NM 5	0.6 (Springvale)
S 510	145.5 (Manz)
S 855	165.1 (Manz)

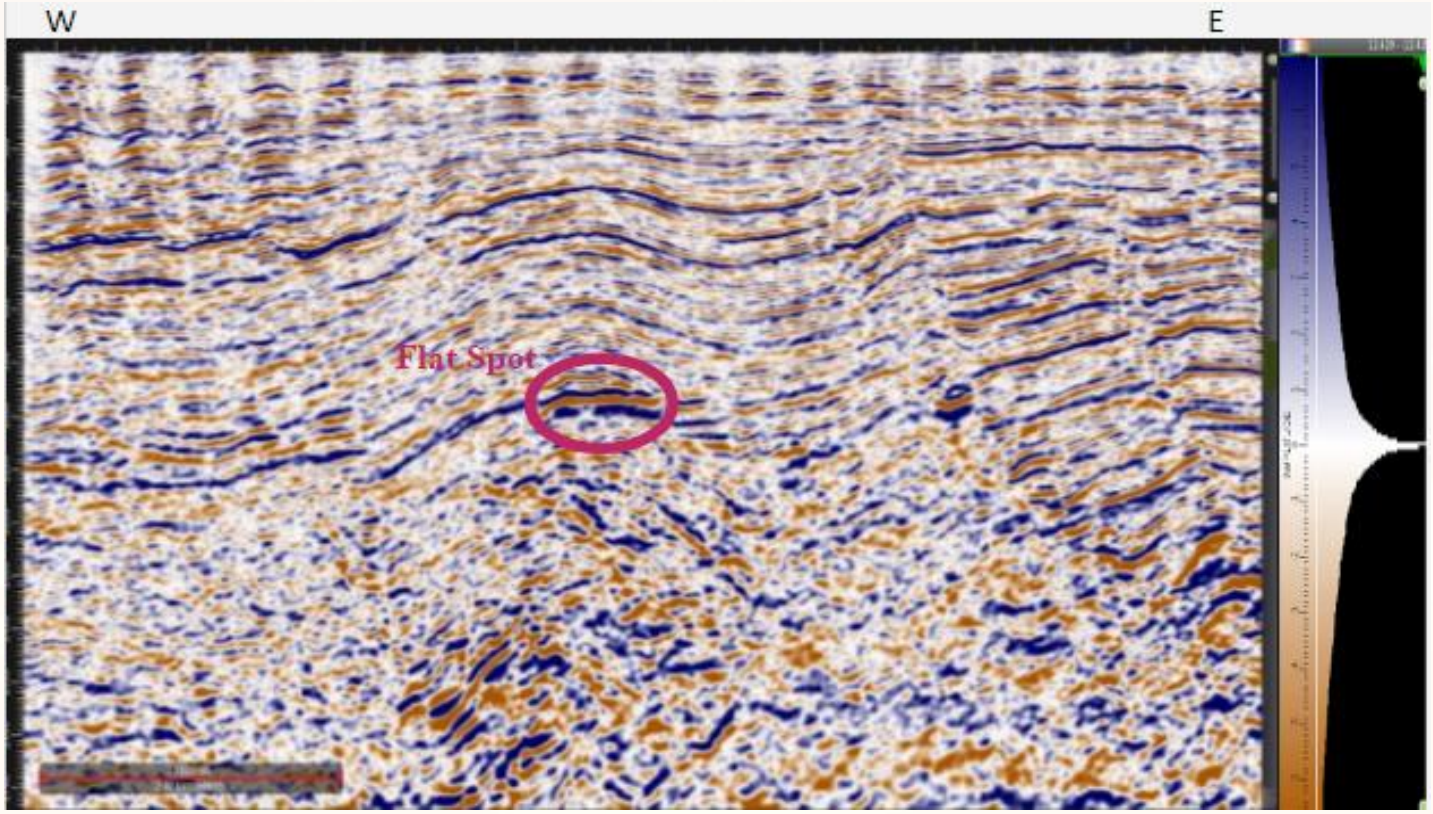
Re-interpretation of S 659

After acquiring new 3D seismic data in 2014 over operated acreages , a geophysical lead, “a flat spot” was identified in the S 659 area (on fast track dataset).



Flat Spot

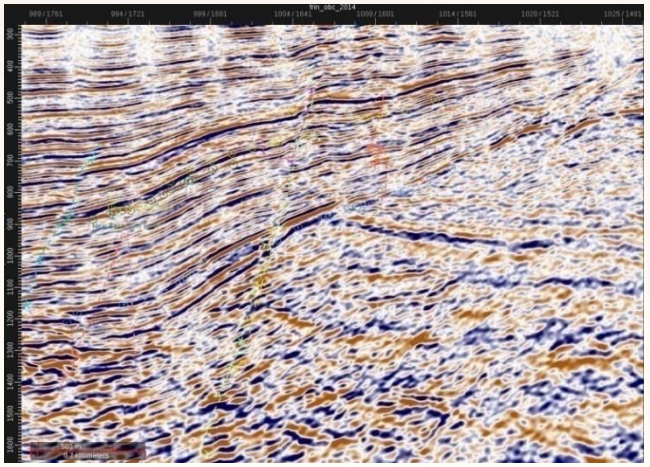
A flat spot is a seismic attribute anomaly that appears as a horizontal reflector cutting across the stratigraphy on the seismic image. Flat spots are recognized as direct hydrocarbon indicators, and typically occur as a result of increased acoustic impedance. (Telford 1990)



Reinterpretations

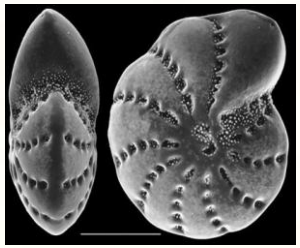
Seismic Stratigraphy

- ✓ Enhanced quality data than legacy data.
- ✓ Preliminary 2014 interpretation reveals a higher degree of faulting.
- ✓ Several fault blocks comprise favorable geometries for trapping petroleum.



High Resolution Biostratigraphy and Integration of Palynostratigraphy

- ✓Detailed high resolution analyses on S 659 and surrounding wells.
- ✓Palynostratigraphic data of surrounding wells applied to study area.

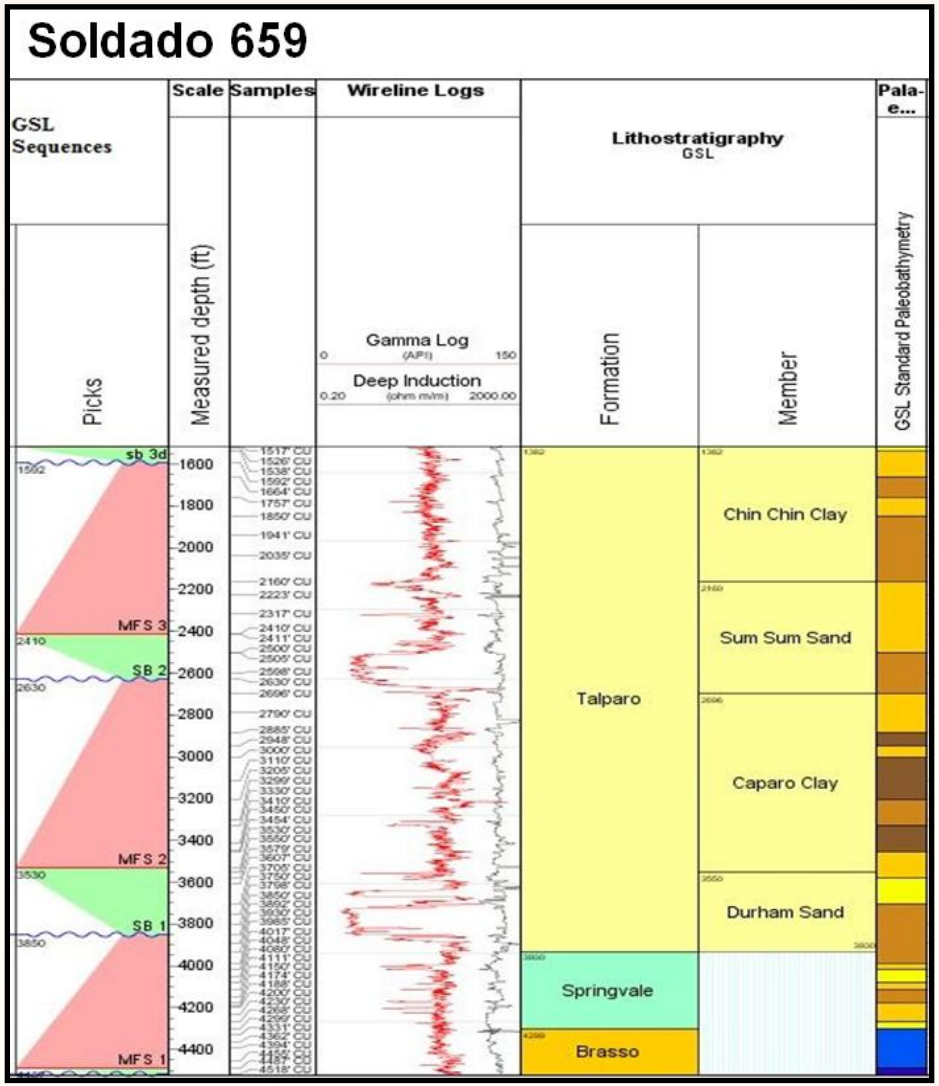


Elphidium advenum maorium

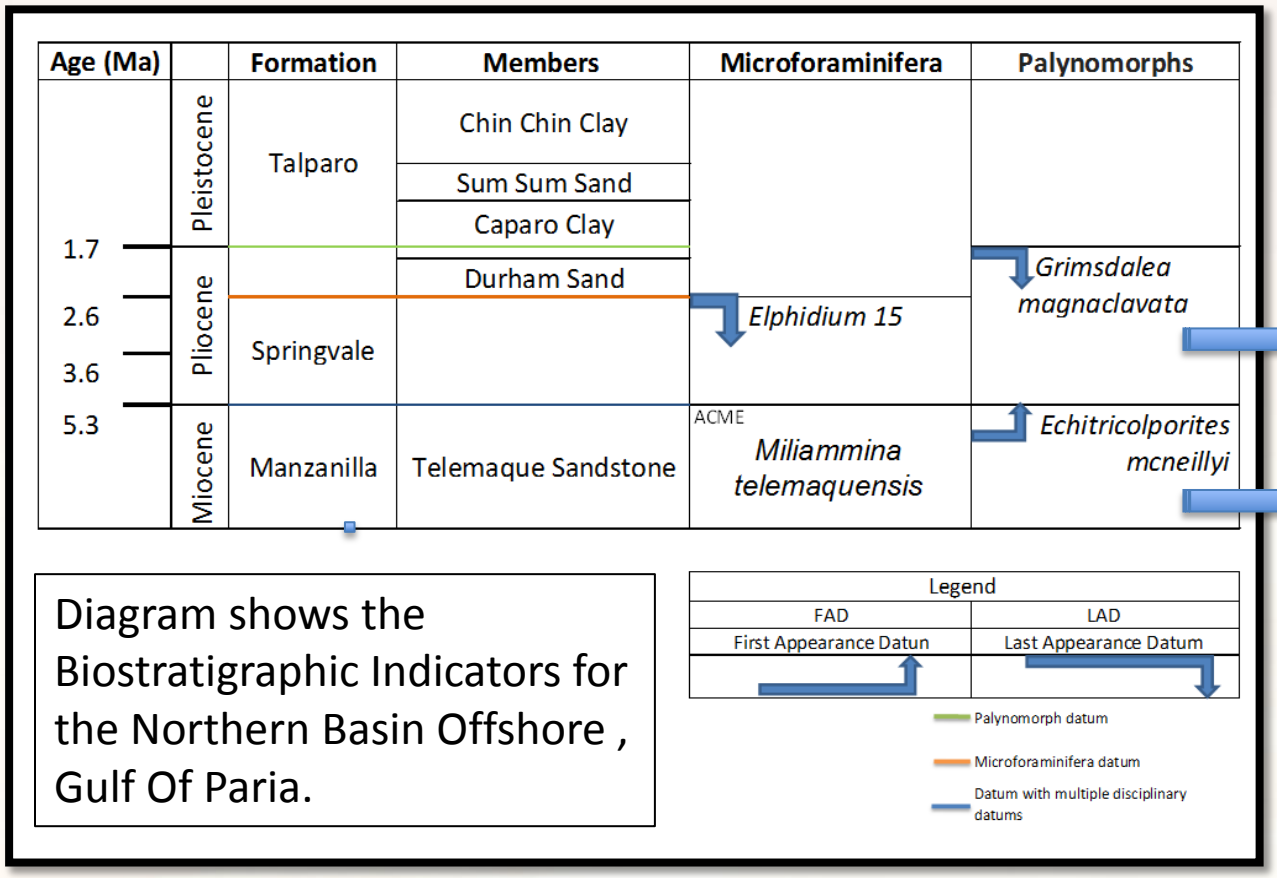
Grimsdalea magnaclavata

Biostratigraphy

- Major part of the Talparo Formation contains Rotalia and Elphidium assemblages. This is believed to live in brackish to marine environment close to shore.
- Faunal assemblage found within the Springvale Formation : *Rotalia beccarii*, *Ammobaculites spp*. and *Elphidium 15.*
- Brasso fauna deposited in an outer neritic setting. Faunal assemblage contains *Cyclammina cancellata , Discammodies tobleri* ad *Globorotalia fohsi peripheroronda.*



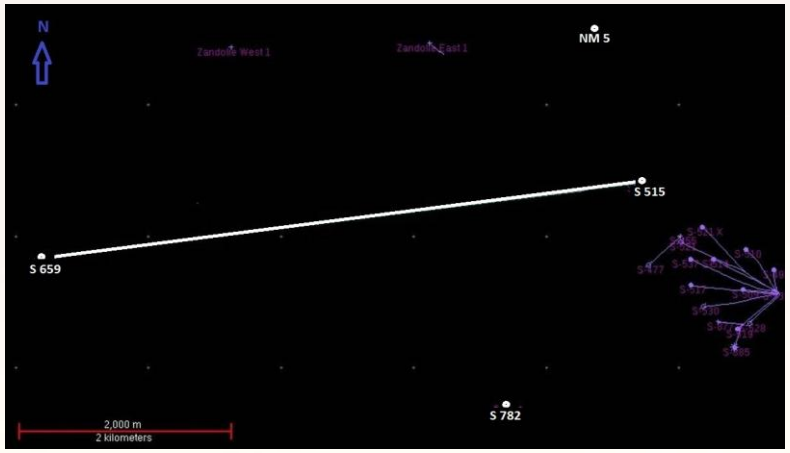
Localised Palynological Zonation

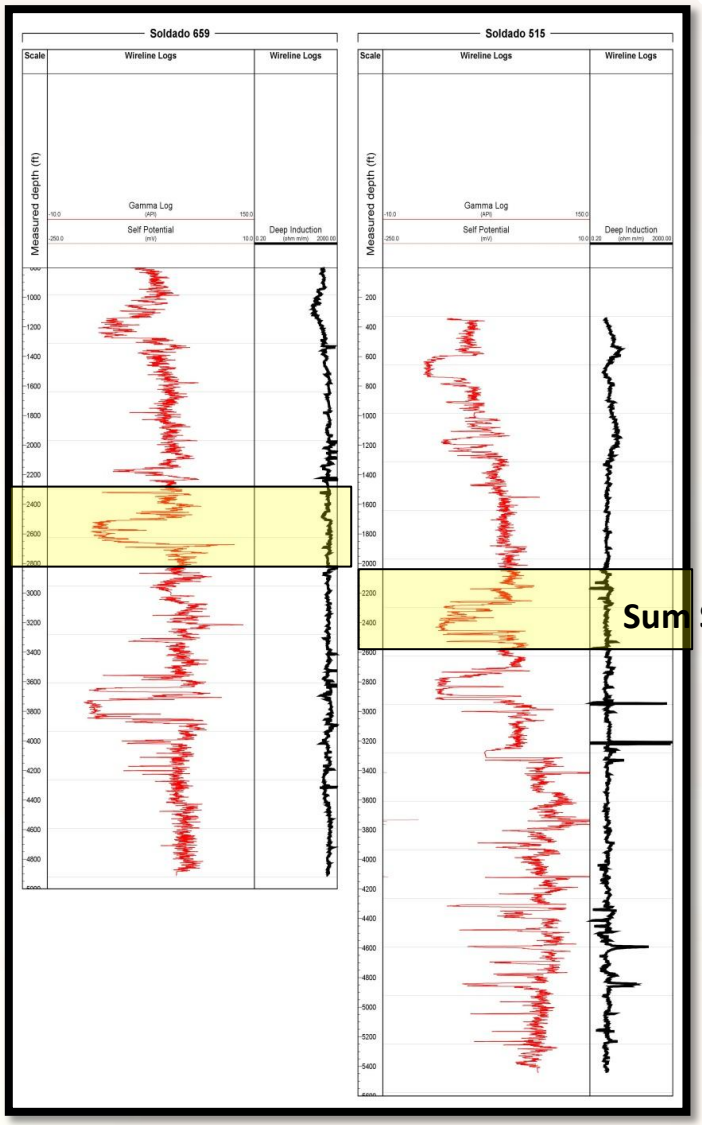


- ✓ Grimsdalea magnaclavata- swampy (Germeraad et al, 1968; Rull 1997)
- ✓ Echitricolporites mcneillyi – Mangrove – open vegetation; aquatic (Germeraad et al, 1968; Rull 1997)

The palynomorphs and microforaminifera ecological interpretations were similar in describing the deposition in a marginal marine setting (Late Miocene – Pleistocene).

Well Log Correlation

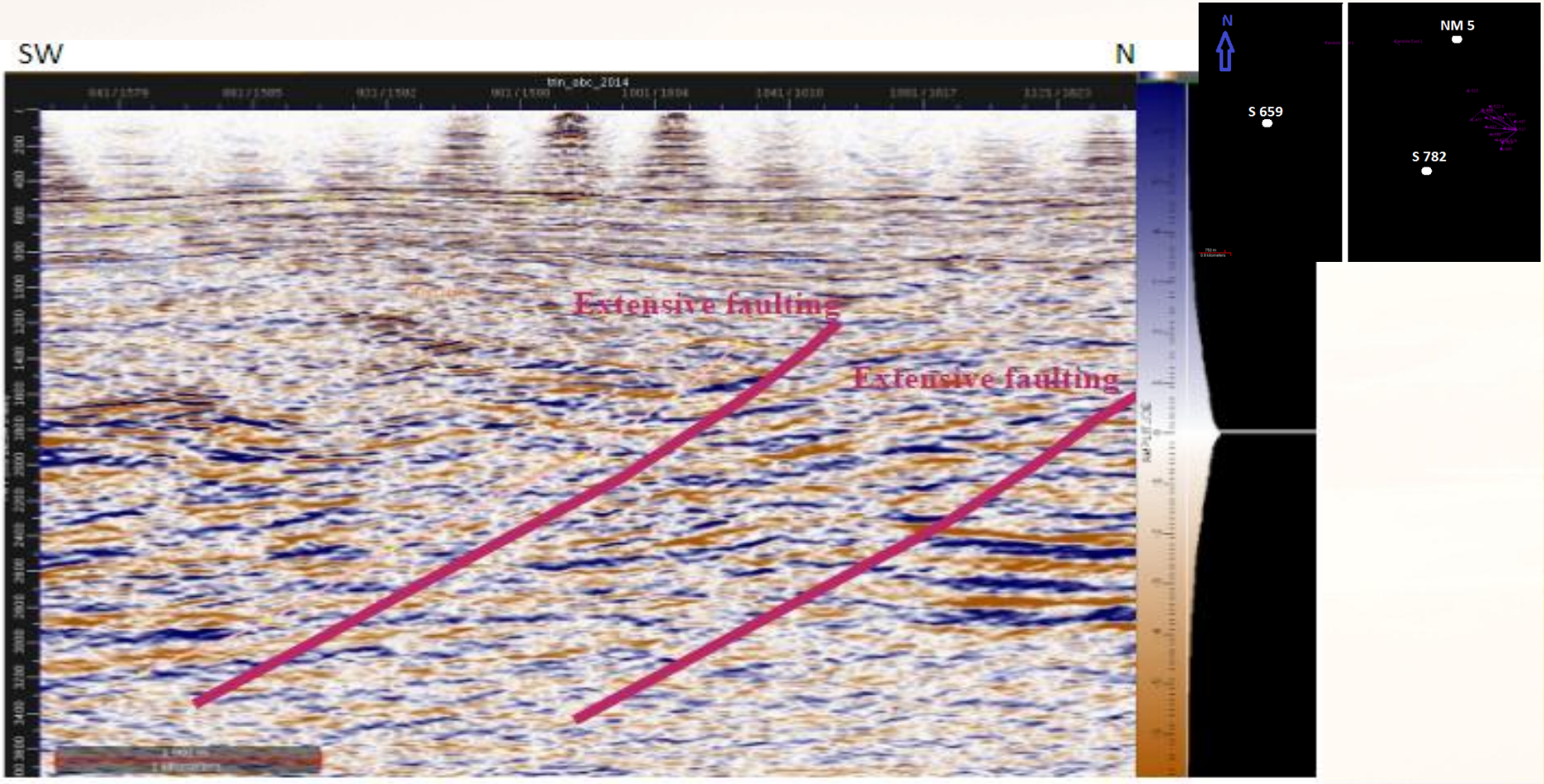




Age diagnostic fauna are not found in the younger sections , hence well log motifs were used to identify the members within the Talparo Formation.

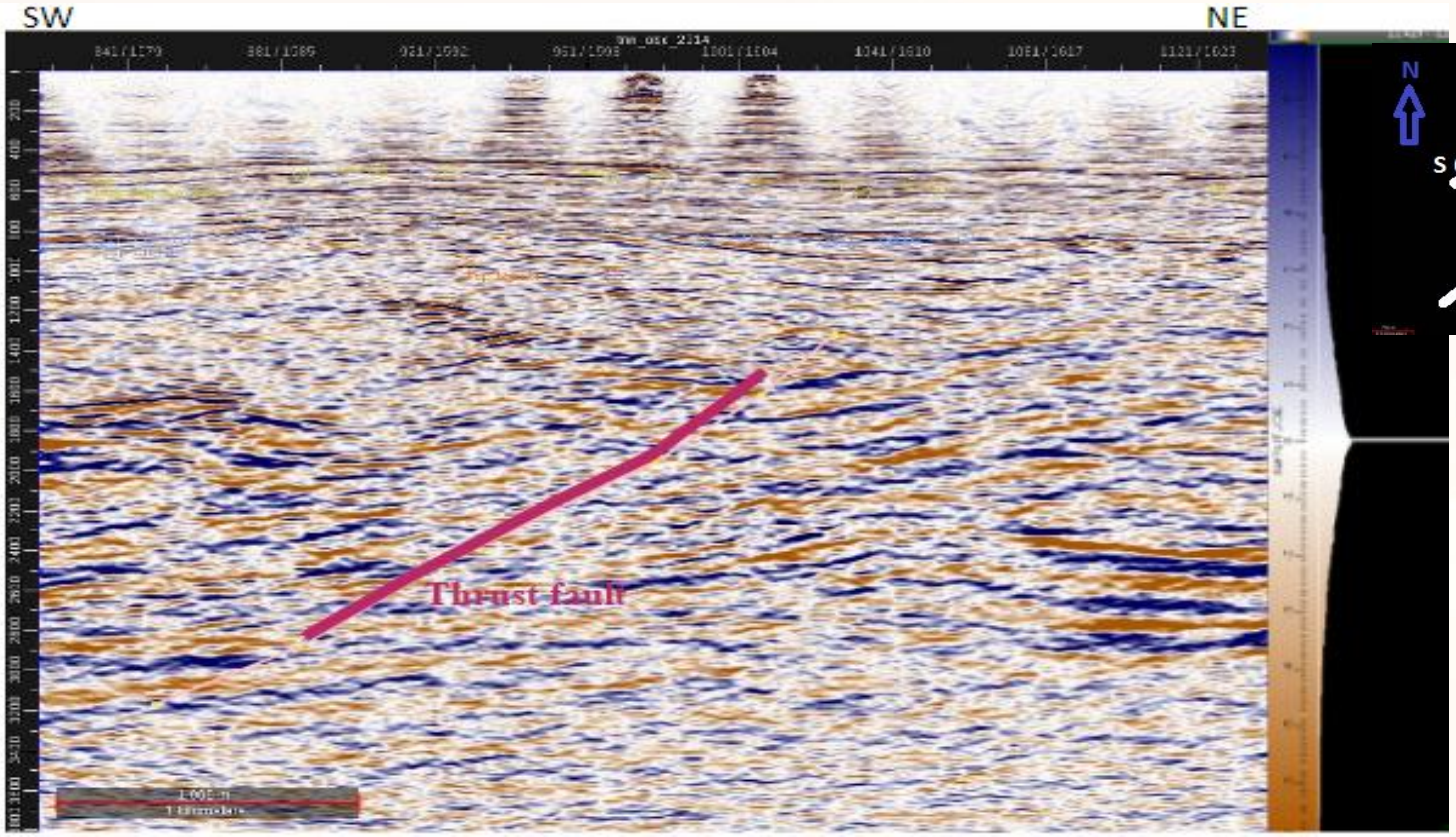
Trap - Normal Faults

Extensive normal faulting is observed which is characteristic of extension and in some cases—inversion tectonics.

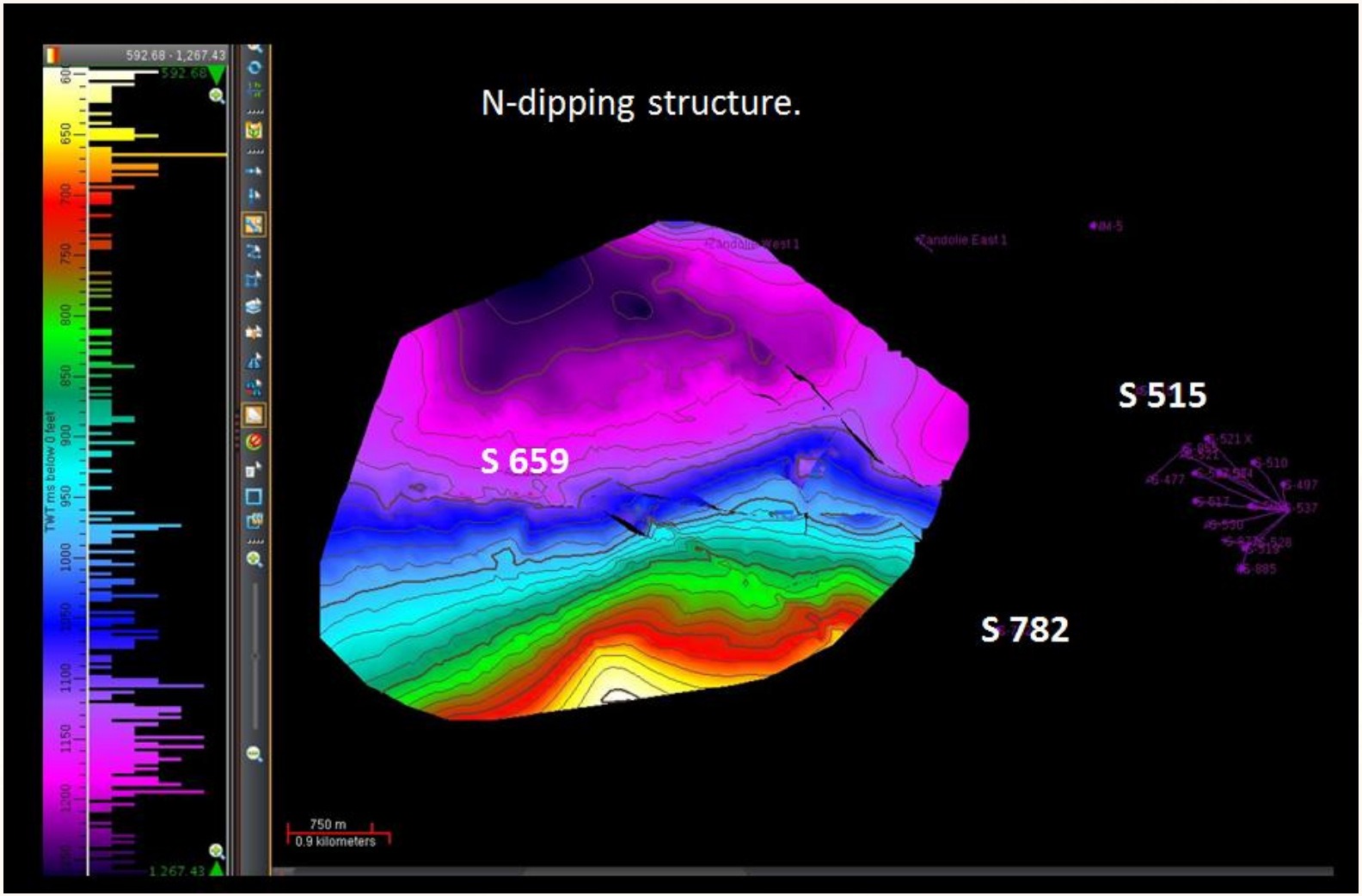


Trap - Thrust Faults

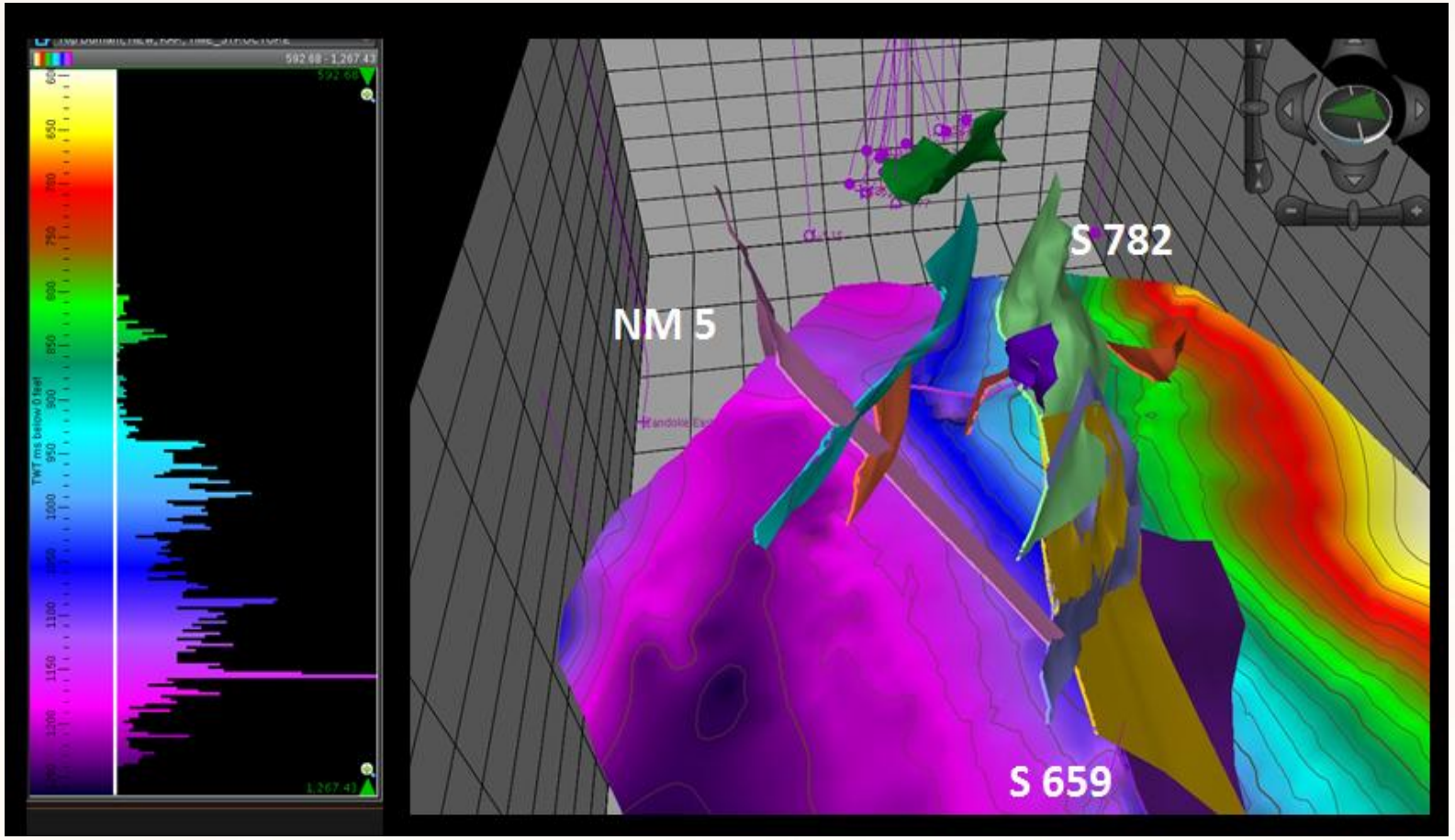
Thrust faults are observed within the deeper Miocene Nariva stratigraphy, which were formed as a result of compressional tectonics and possibly set up the major structure within the study area. The shape of the fault controls the shape of the fold.



Time Structure Map on Top Durham



Structural Model

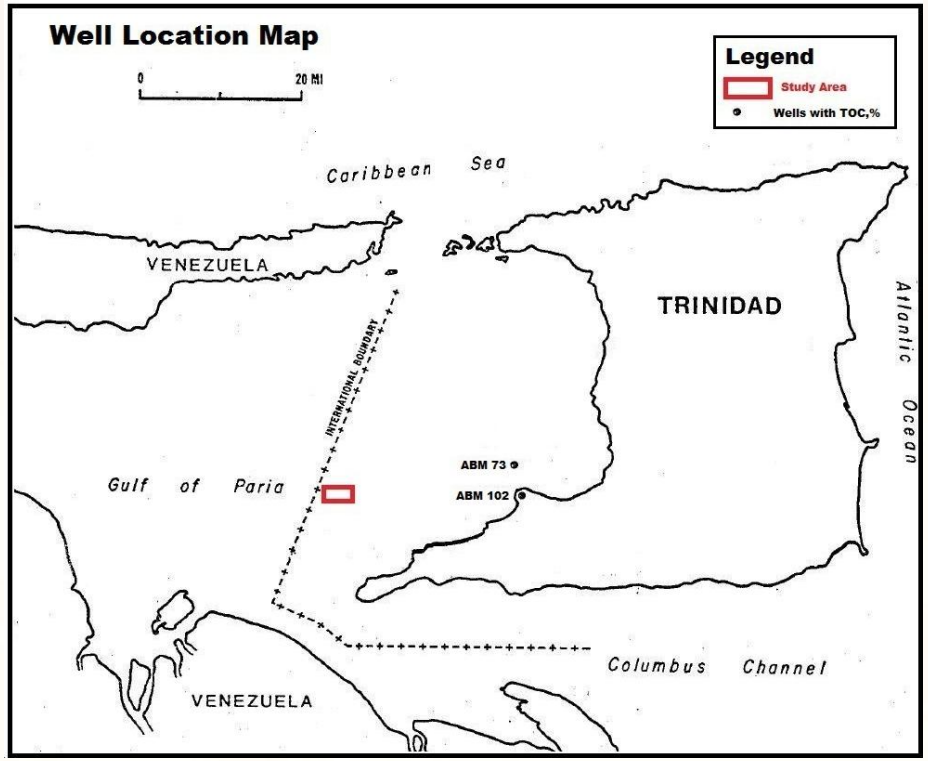


SW-NE trending normal faults, together with thrust faults set up potential traps against the updip/folded limb.

Petroleum Systems (1)

The TOC values of the rocks examined have a good to very good potential for the generation of hydrocarbon.

Well Number	TOC , %
AB 102	5.64
ABM 73	1.91



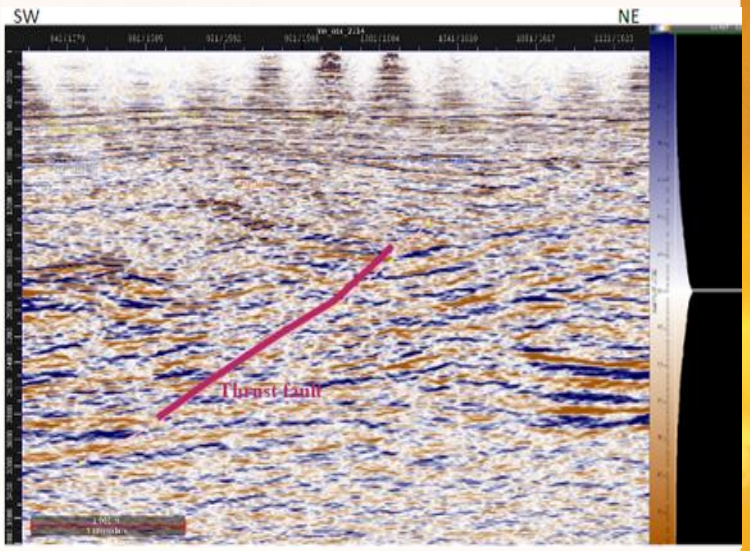
(Kuarsingh, Internal Petrotrin Report)

The kerogens are dominated by amorphous material in some rocks and woody and herbaceous materials in others ,these rocks are expected to generate a mixture of oil and gas.

Petroleum Systems (2)

Excellent traps for hydrocarbons in the Brasso, Manzanilla and Springvale Formations

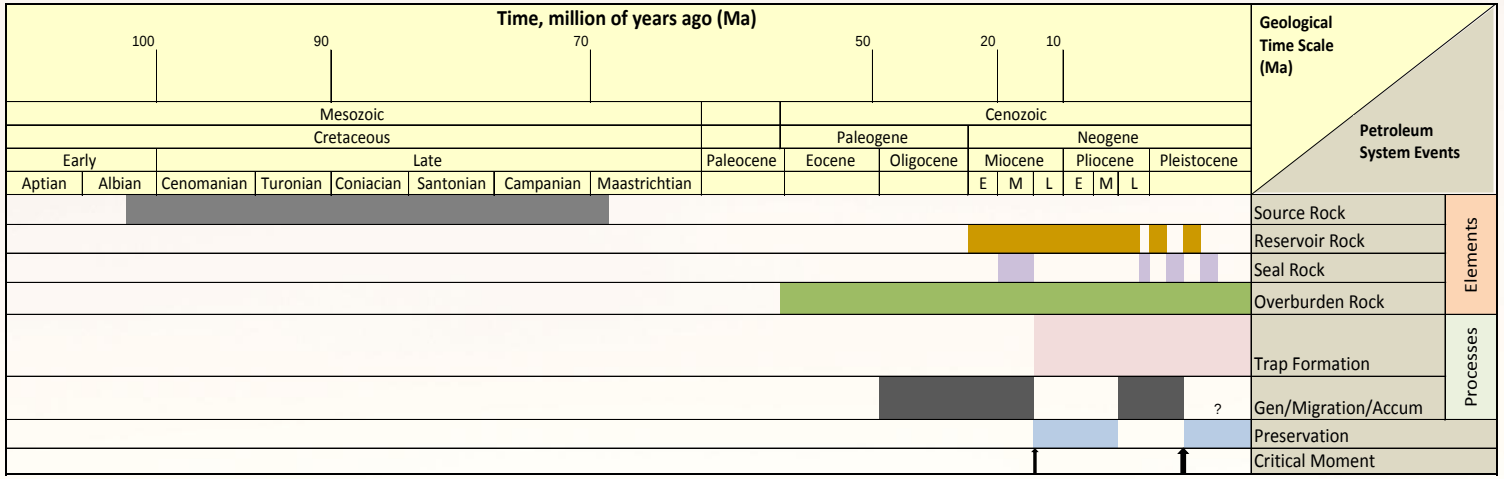
Thrust faults may also act as migration pathways. The Late Miocene to Pliocene generation and expulsion timing makes it very prospective, since at the time of migration the trap is formed. Migration into the younger reservoirs may be aided by the strike-slip faults which cut very deep.



Interbedded shales act as seals

Maximum flooding surfaces with hundreds of meters thick shale act as good seals (shale beds found within the Talparo , Springvale and Manzanilla Formation).

Summary



- New understanding of the “flat spot”(based on fast track dataset).
- Better understanding of variations within the main lithostratigraphic units.
- Better understanding of spatial distribution of quality reservoir and seal.

Conclusions

The Soldado 659 area is a offshore concession which is under explored and a petroleum system is identified.

- Fold and thrust belts are challenging frontiers for hydrocarbon exploration because of complex/uncertain structural geometry.
- This area with a working petroleum system is a promising hydrocarbon exploration target but uncertain trap definition
- 2014 Seismic provided better resolution over legacy data.
- On the recent seismic dataset, there is an increase in faulting and structures currently being interpreted.

Future Work

- Further interpretation on final seismic volumes will confirm flat spot as DHI and processed volumes will resolve any issues observed on the fast track dataset.

- Propose an appraisal well to test this geophysical feature , “flat spot”.

References

Armentrout, J.M., 1996. Integrated Stratigraphic Analysis. SEPM Course No. 17.

Geological Review Team, 1967. Review of T.N.A. and T.P.D. Gulf of Paria Leases, Trinidad. Trinmar Limited, Guapo, Trinidad Geological Depart-ment.

Haq, B.L., Hardenbol, J., & Vail, P.R., 1987. The New Chronostratigraphic Basis of Cenozoic and Mesozoic Sea Level Cycles. Figure 1. Cush-man Foundation for Foraminiferal Research, Special Publication No. 24.

PetroStrat Ltd. , 2009. Biostratigraphy and Review of Block 1a/1b; Gulf of Paria , Trinidad and Tobago.

Pindell, J.L., and Kennan, L., 2007, Cenozoic Kinematics and Dynamics of Oblique Collision Between two Convergent Plate Margins: The Caribbean-South America Collision in Eastern Venezuela , Trinidad and Barbados, Transactions of GCSSEPM 27th Annual Bob F. Perkins Research Conference , 458-553.

Pocknall, D.T., and Jarzen, D.M.,2012 , Grimsdalea magnaclavata Germeraad, Hopping & Muller : an enigmatic pollen type from the Neogene of northern South America. The Palynological Society Volume 40

Tectonic Analysis , 2004. Paleogeographic Mapping and Documentation of Sandstones/Reservoir Systems, Paleogene to Mid-Miocene of Trinidad and Eastern Venezuela. Part A – Data Sources.

Van Wagoner, J.C., Mitchum, R.M., Campion, K.M. & Rahmanian, V.D., 1990. Siliciclastic Sequence Stratigraphy in Well Logs, Cores, and Out-crops. Concepts for High-Resolution Correlation of Time and Facies. AAPG Methods in Exploration Series, No. 7.

Ramroop et al, 1994. Lagoven/Petrotrin Joint Geological Study—Gulf of Paria. Field trip Guide—Trinidad Leg.

Kugler, Hans G. *The Stratigraphic Lexicon of Trinidad.* n.d.—. *Treatise on the Geology of Trinidad: Part 4 Paleocene to Holocene formations.* Edit-ed by H.M Bolli and M. Knappertsbusch. n.d.

Pindell, James, and Lorcan Kennan. “Kinematic Evolution of the Gulf of Mexico and Caribbean.” 2005.

Ramlackhansingh, Anthony. “Petroleum Geology of the Southeast Caribbean.” *Petroleum Geology of the Southeast Caribbean Class notes.* St. Augustine, 2010.

Acknowledgements

Geological Services Laboratory Team

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Nancy Gallai-Ragobar , Petrotrin

Petrotrin

Thank You

Questions?