

ECONOMIC VIABILITY RE-ESTIMATION OF HYDROCARBON RESERVE OF EMAKPE-FIELD, NORTHERN DEPOBELT, ONSHORE NIGER DELTA SEDIMENTARY BASIN, NIGERIA

Auduson, A. E. and Ayinde M. A.*

Abstract

This paper presents the report of the hydrocarbon reserve investigation carried out using the data set for the Emakpe-field, in the Northern Depobelt of the Niger Delta Sedimentary Basin. The objective of this work was to map out the hydrocarbon reservoir(s) within this field, using the available data set including 3D seismic, well and biostratigraphic in an integrated approach in order to ascertain the economic viability. To this end, 3D seismic data with drilled five wells were analysed, which were correlated in order to control the geology of the field, as well as understand the reservoir properties at each well location. Using industry-standard program, seismic interpretation was extensively carried out in order to determine the geologic framework, model the Stratigraphy and the structural styles of the field. Thus, various horizons and faults were interpreted for the establishment of the stratigraphic and structural framework of the field respectively. Fault interpretation was carried out on 3D seismic window and wells were tied to a seismic section via the construction of synthetic seismogram model. Seismic visualization and further analysis show some seismic attributes such as high amplitude, bright spots and zones of chaotic reflections. Sequel to seismic horizons and fault interpretation across the field, map extrapolation and reserves estimation were carried out to determine the volume of hydrocarbon present in the field. Volumetric analysis shows an estimated OOIP value greater than 100 million barrels, classified into a mid-sized field. Hence, the Emakpe-Field is economically viable and recommended for further investment.

Key Words: Economic viability, volumetric analysis, Fault interpretation, Seismic interpretation, Well correlation

1.0 Introduction

The Niger Delta Petroleum Province, have over geologic time (Eocene to the present) formed depobelts that represent the most active portion of the delta at each stage of its development, having prograded southwestward¹. The Niger Delta Province contains only one identified petroleum system²³. This system is referred to as Tertiary Niger Delta (Akata –Agbada) Petroleum System. The maximum extent of the petroleum system coincides with the boundaries of the province. The minimum extent of the system is defined by the areal extent of fields and contains known resources (cumulative production plus proved reserves) of 34.5 billion barrels of oil (BBO) and 93.8 trillion cubic feet of gas (TCFG) (14.9 billion barrels of oil equivalent, BBOE)⁴. Most of this petroleum has been in fields within the onshore or on the continental shelf in waters less than 200 meters deep and occurs primarily in large, relatively simple structures.

The northern depobelts portion of the Akata-Agbada petroleum system correspond geographically and stratigraphically to the northernmost part of the six depobelts recognized in the Niger delta. The portion of the system has a total surface area of 7675km² and has been estimated to contain about 3 billion bbl of mostly light waxy crude oil and over 7 trillion scf of gas. These hydrocarbons have been exploitation targets, hence, subjected to depletion in the course of exploration and production

* Authors are in Department of Geology, Federal University, Lokoja, Nigeria

Corresponding author's email address: aaron.auduson@fulokoja.edu.ng

¹ Tuttle, M. L. W., Charpentier, Ronald R. and Brownfield, Michael E. (1999). The Niger Delta Petroleum System: Niger Delta Province, Nigeria, Cameroon, and Equatorial Guinea, Africa, U. S. Department of Interior, U. S. Geological Survey Open File Report 99-50H.

² Burke, K., (1972). Longshore drift, submarine canyons, and submarine fans in development of Niger Delta: American Association of Petroleum Geologists, v. 56, p. 1975-1983.

³ Ekweozor, C. M., and Daukoru, E.M, 1994, Northern Delta Depobelt portion of the Akata-Agbada(!) petroleum system, Niger Delta, Nigeria, in, Magoon, L.B., and Dow, W.G., eds., The Petroleum System--From Source to Trap, AAPG Memoir 60: Tulsa, American Association of Petroleum Geologists, p. 599-614

⁴ Tuttle, M. L. W., Charpentier, Ronald R. and Brownfield, Michael E. Op. Cit

activities in the onshore Niger Delta over a period time (since late 1950s when commercial discovery of petroleum in Nigeria to 2010, when the onshore reserve is believed to have reached climax). Emakpe-Field is an onshore oil field with a few gas-bearing reservoirs located in the western part of OML 111 within the Northern Depobelts, believed to have experienced changes in the volume of hydrocarbon due exploration and production activities.

Thus, a thorough, higher-resolution data analysis for economic analysis is required in order to capture prime areas, estimate the reserve and viability or otherwise of the field. The objectives of this study therefore were: (1) to understand the structural style of the field; (2) to map out the hydrocarbon reservoir (s) within the field, using the available data set in an integrated approach; (3) estimate the volume of hydrocarbon in place and hence indicate the economic viability of the field for prospective investors. To this end, 3D seismic, well and production data were integrated and analysed for delineation of the structures and horizons, petrophysical characteristics and calculation of the hydrocarbon volume in place. Five wells drilled in the field to appraise and develop the field, encountered 19 hydrocarbon bearing sands within the depth range of 8,279 ft and 10,850 ft. The field has 11 oil bearing reservoirs, 3 gas bearing reservoirs and 5 associate gas reservoirs. For the purpose of this study, only 3 oil bearing reservoirs were analysed and interpreted.

2.0 Synoptic Geology of the Niger Delta

The onshore portion of the Niger Delta Province is delineated by the geology of southern Nigeria and southwestern Cameroon. The province covers 300,000 km² and includes the geologic extent of the Tertiary Niger Delta (Akata-Agbada) Petroleum System. The structural framework the field is defined by a NW–SE trending macro and micro-structural building listric faults and the conspicuous absence of a counter regional fault which characterizes the Northern Depobelts of the Niger Delta (Figure 1). The hydrocarbon trapping mechanism ranges from fault-assisted rollover anticlines to dip closures (Four-way) observed within the field⁵.

⁵ Nichols, G. (2009) Sedimentology and Stratigraphy. Blackwell Science Ltd., London, 335 p.

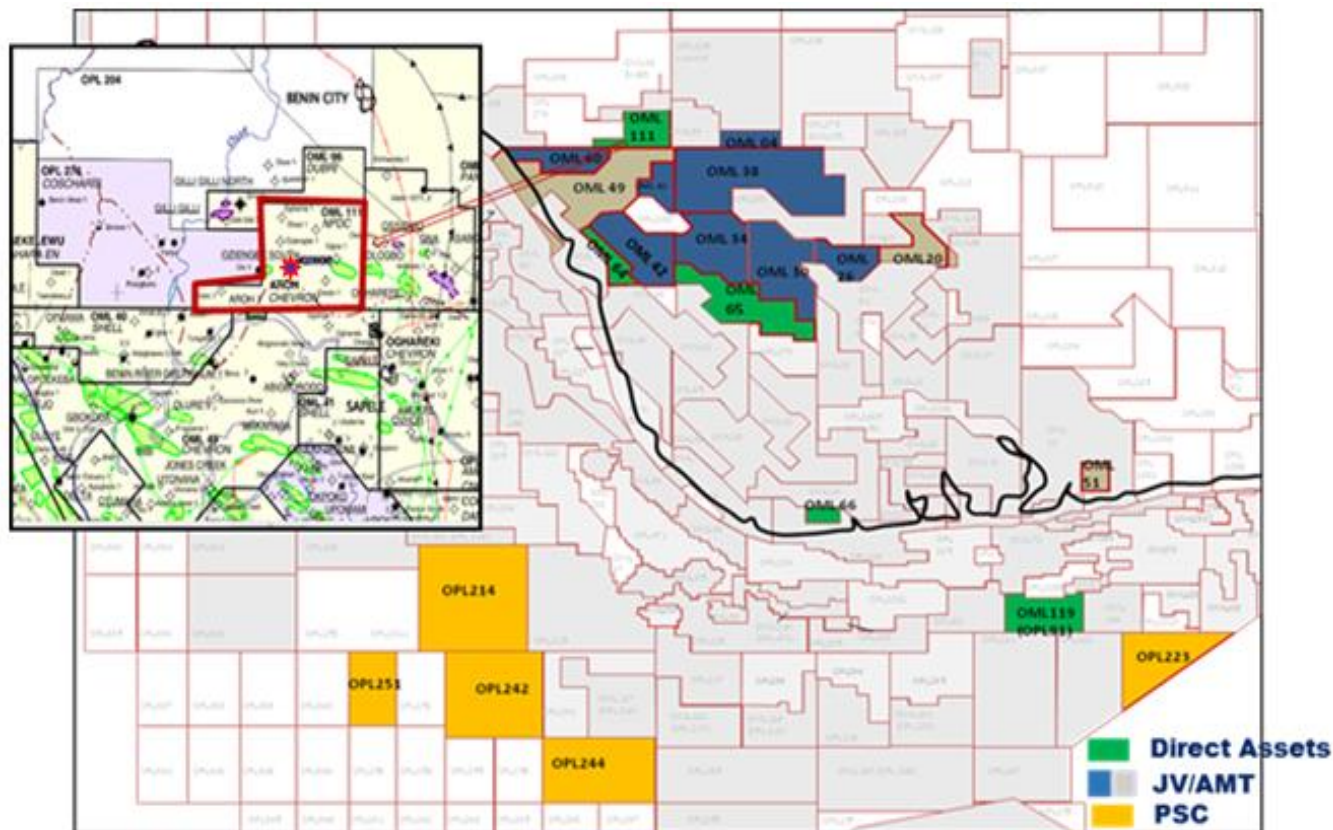


Figure 1: Emakpe-Field location (red polygon in the inset map).

2.1 Tectonic evolution

Tectonically, Niger Delta is influenced by the tectonic framework of the continental margin along the West Coast of equatorial Africa, which is controlled by Cretaceous fracture zones expressed as trenches and ridges in the deep Atlantic⁶ (Tuttle et al, 1999). The fracture zone ridges subdivide the margin into individual basins, and, in Nigeria, form the boundary faults of the Cretaceous Benue-Abakaliki trough, which cuts far into the West African shield. Rifting started in the Late Jurassic and persisted into the Middle Cretaceous⁷. In the region of the Niger Delta, rifting diminished altogether in the Late Cretaceous. Shale mobility induced internal deformation and occurred in response to two processes⁸. First, shale diapirs formed from loading of poorly compacted, over-pressured, prodelta and delta-slope clays (Akata Fm.) by the higher density delta-front sands (Agbada Fm.). Second, slope instability occurred due to a lack of lateral, basinward, support for the under-compacted delta-slope clays (Akata Fm). For any given depobelt, gravity tectonics were completed before deposition of the Benue Formation and are expressed in complex structures, including shale diapirs, roll-over anticlines, collapsed growth fault crests, back-to-back features, and steeply dipping, closely spaced flank faults⁹.

2.2 Lithology

⁶ Tuttle, M. L. W., Charpentier, Ronald R. and Brownfield, Michael E. Op. Cit

⁷ Lehner, P., and De Ruiter, P.A.C., 1977, Structural history of Atlantic Margin of Africa: American Association of Petroleum Geologists Bulletin, v. 61, p. 961-981.

⁸ Kulke, H., 1995, Nigeria, in, Kulke, H., ed., Regional Petroleum Geology of the World. Part II: Africa, America, Australia and Antarctica: Berlin, Gebrüder Borntraeger, p. 143-172.

⁹ Nwajide, C. S. (2013) Geology of Nigeria's Sedimentary Basins. CSS Bookshops Limited, Lagos.

The Cretaceous section has not been penetrated beneath the Niger Delta Basin, the youngest and southernmost sub-basin in the Benue-Abakaliki trough¹⁰. In the Paleocene, a major transgression began with the Imo shale being deposited in the Anambra Basin to the northeast and the Akata shale in the Niger Delta Basin area to the southwest. In the Eocene, the coastline shape became convexly curvilinear, the longshore drift cells switched to divergent, and sedimentation changed to being wave-dominated¹¹. The Tertiary section of the Niger Delta is divided into three formations, representing prograding depositional facies that are distinguished mostly on the basis of sand-shale ratios. The Akata Formation at the base of the delta is of marine origin and is composed of thick shale sequences (potential source rock), turbidite sand (potential reservoirs in deep water), and minor amounts of clay and silt. Beginning in the Paleocene and through the Recent, the Akata Formation formed during low stands when terrestrial organic matter and clays were transported to deep water areas characterized by low energy conditions and oxygen deficiency¹². It is estimated that the formation is up to 7,000 meters thick¹³. The formation underlies the entire delta and is typically over pressured. Turbidity currents likely deposited deep sea fan sands within the upper Akata Formation during development of the delta¹⁴. Deposition of the overlying Agbada Formation, the major petroleum-bearing unit, began in the Eocene and continues into the Recent. The clastic accumulated in delta-front, delta-topset, and fluvio-deltaic environments. In the lower Agbada Formation, shale and sandstone beds were deposited in equal proportions, however, the upper portion is mostly sand with only minor shale interbeds. The Agbada Formation is overlain by the third formation, the Benin Formation, a continental latest Eocene to Recent deposit of alluvial and upper coastal plain sands that are up to 2000 m thick¹⁵.

2.3 Depobelts

Deposition of the three formations occurred in each of the five off lapping siliciclastic sedimentation cycles, referred to as depobelts, which comprise the Niger Delta. These depobelts are 30-60 kilometers wide, prograde south-westward 250 kilometers over oceanic crust into the Gulf of Guinea¹⁶, and are defined by synsedimentary faulting that occurred in response to variable rates of subsidence and sediment supply¹⁷. The interplay of subsidence and supply rates resulted in deposition of discrete depobelts. When further crustal subsidence of the basin could no longer be accommodated, the focus of sediment deposition shifted seaward, forming a new depobelt¹⁸. Each depobelt is a separate unit that corresponds to a break in regional dip of the delta and is bounded landward by growth faults and seaward by large counter-regional faults or the growth fault of the next seaward belt^{19 20}. Five major depobelts are generally recognized, each with its own sedimentation, deformation, and petroleum history (Figure 2).

¹⁰ Reijers, T.J.A., Petters, S.W., and Nwajide, C. S., 1997, The Niger Delta Basin, in Selley, R.C., ed., African Basins—Sedimentary Basin of the World 3: Amsterdam, Elsevier Science, pp. 151-172.

¹¹ Reijers, T.J.A., Petters, S.W., and Nwajide, C. S. Op. Cit

¹² Stacher, P., 1995, Present understanding of the Niger Delta hydrocarbon habitat, in, Oti, M.N., and Postma, G., eds., Geology of Deltas: Rotterdam, A.A. Balkema, p. 257-267.

¹³ Doust, H., and Omatsola, E., 1990, Niger Delta, in, Edwards, J. D., and Santogrossi, P.A., eds., Divergent/passive Margin Basins, AAPG Memoir 48: Tulsa, American Association of Petroleum Geologists, p.239-248.

¹⁴ Kulke, H., 1995, Nigeria, in, Kulke, H. Op. Cit

¹⁵ Avbovbo, A. A., 1978, Tertiary lithostratigraphy of Niger Delta: American Association of Petroleum Geologists Bulletin, v.62, p. 295-300.

¹⁶ Stacher, P. Op. Cit

¹⁷ Doust, H., and Omatsola, E. Op. Cit

¹⁸ Doust, H., and Omatsola, E. Op. Cit

¹⁹ Evamy, B. D., Haremboure, J., Kamerling, P., Knaap, W. A., Molloy, F. A., and Rowlands, P.H., 1978, Hydrocarbon habitat of Tertiary Niger Delta: American Association of Petroleum Geologists Bulletin, v. 62, p. 277-298.

²⁰ Doust, H., and Omatsola, E. Op. Cit

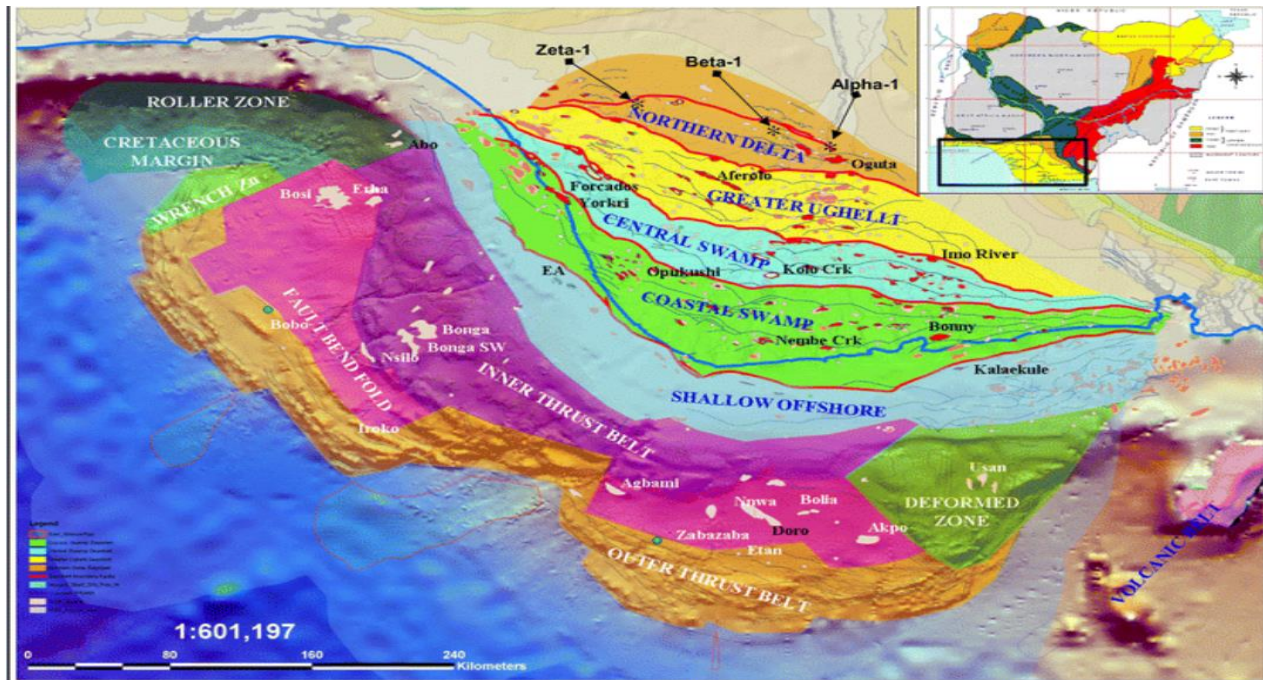


Figure 2: The Niger Delta depobelts, including Northern Delta, Greater Ugheli, Central Swap, Costal Swamp and Shallow offshore.

²¹describe three depobelt provinces based on structure. The northern delta province, within which our study is located overlies relatively shallow basement and has the oldest growth faults that are generally rotational, evenly spaced, and increase their steepness seaward. The central delta province has depobelt with well-defined structures such as successively deeper rollover crests that shift seaward for any given growth fault. Last, the distal delta province is the most structurally complex due to internal gravity tectonics on the modern continental slope.

3.0 Methodology

Using industry-standard software, the specified projection coordinate system namely (Mina/Nigeria West Belt [SIS-501784] was set to Field-UTM system in line with the data provided. Datasets used in this study was provided by an oil and gas producing company in the region, including Poststack three-dimensional Seismic data, covering an area of 652 km²; well data including calibrated well information, Total depth, measured depth, deviated well data (with Azimuth, Inclination), sand file, as well as Well head data, which were loaded in an integrated approach used for the already producing field in other to maintain initial information about the well, and which was to be related with the new information about the well (Table 1). Check shot data were provided for wells Ema-01, Emakpe S1 and Emakpe S2; from which check shot data from Ema-01 was used to convert from time to depth across the survey.

Three main techniques were adapted in the methodology of this study involving seismic interpretation and analysis, petrophysical data analysis and volumetric calculation. While the 3D seismic data was used to identify the faults, horizons, boundaries and reservoir geometries, petrophysical model was built from the well log data (Ema-001, Emakpe South 001, Emakpe South 002, Emakpe South 004, and Emakpe South 005). The identified lithologies and shale content were used for well correlation. Estimation of the reserve was carried out use of the Net pay analysis.

²¹ Doust, H., and Omatsola, E. Op. Cit

Table 1: A table showing the data format as loaded for Emakpe-Field

Data type	No.	Coverage	Data Format
3D Seismic Vintage	1	Emakpe field (652 km ²)	SEGY
Well Logs	5	Ema-01, Emakpe South 4, South-5, South-1 and South-2	Las
Deviation	3	Ema-01, Emakpe S4 and Emakpe S5	Las
Check shot	No	Ema-01, Emakpe S1 and Emakpe S2	Text
Time-Depth Conversion	1	Ema-01, Check shot	Text
Seismic Processing Report	No	No	No
End of Well Report	No	No	No
Sand file	19	A100, A300, A400, A500, A600, A700, B100, B200, C100, C200, C300, C400 C410, C420, C4500, C600, C700, 800	PDF and Las
Wel Header	5	Ema-01, Emakpe South 4, South-5, b, South-1 and South-2	Text

4. Results and Interpretation

Fault interpretation²² was done by generating semblance cube, which helped to ascertain the structural style of the field, which assists in trap delineation. Having established the fault strike through the time slice of the semblance cubes, the fault was interpreted as seen on the dip section of the seismic. The five wells containing composite logs including Laterolog-Deep Resistivity, Bulk Density, Gamma Ray and Neutron Porosity were used for lithology identification, correlation and petrophysical analysis. The logs categorized into three, viz; lithology logs (Gamma Ray, VShale), resistivity logs (Resistivity, Lateral Deep, Lateral Shallow) and the porosity logs (Density and neutron).

4.1 Seismic interpretation and analysis

In few cases, where the fault trend is oblique to the general dip section, an arbitrary section perpendicular to the strike of the fault is taken to enable an accurate interpretation of the fault (Figure 3). The overall structural behaviours of Niger Delta Basin were considered during the fault interpretation. In order to understand the subsurface geology and structural trend for possible hydrocarbon accumulation, seismic and well data were tied. Using the sonic log, density log, deviated survey and wavelet, well-to-Seismic tie was done in order to be able to relate features from well data (tops, faults, cored intervals) to the ‘peaks and troughs’ on the seismic line that pass through each of the well location, as well as model how the individual wavelets caused by the various impedance boundaries around our zone of interest (i.e. reflection coefficients) combine to produce the resultant seismic trace in the interpreted seismic section (Figure 4). This helps us to understand phase and polarity of the data, as well as estimate the wavelength that used for seismic inversion. Thus, well logs measured in depths have been related to seismic data measured in time and the events on the seismogram have been correlated with the well tops on the well logs (Figure

²² Aaron E. Auduson (2018). Concise Applied Geophysics: a Practical Approach. Delizon Publishers, First edition, 2018.
http://www.delizonpublishers.com/shop/index.php?route=product/product&product_id=1: Pp. 246-251

5). The extracted wavelet was convolved with the reflection coefficient, which gave rise to the synthetic seismogram which was tied with the given seismic.

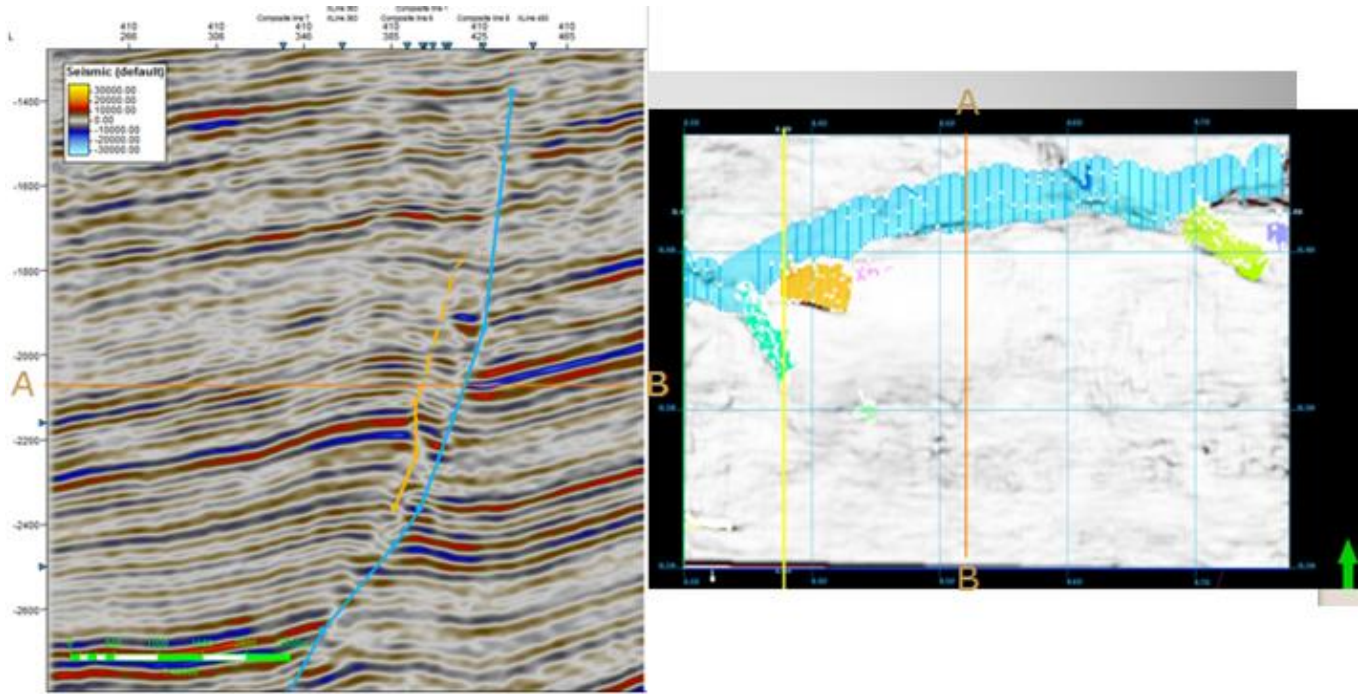


Figure 3: Arbitrary section of a fault take to guarantee accurate interpretation.

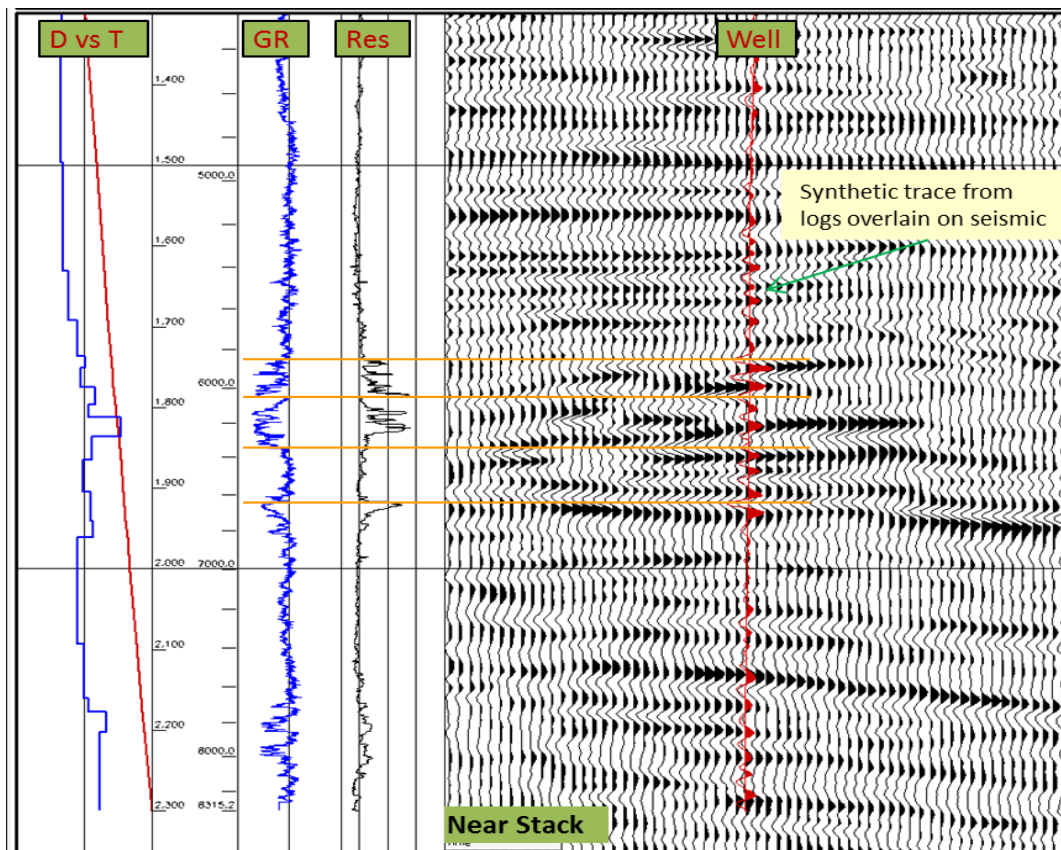


Figure 4: A synthetic trace from logs overlain on seismic

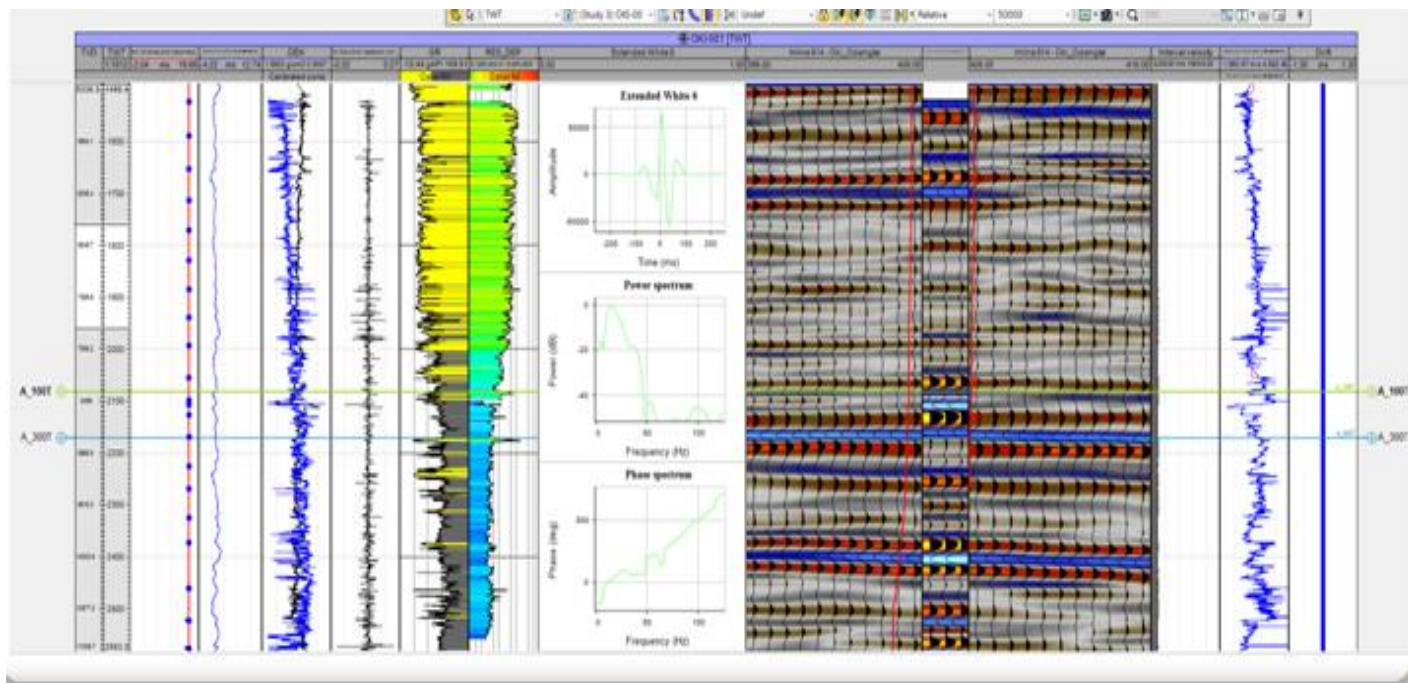


Figure 5: The output of well to seismic tie

Next, the reservoir tops (Figure 6) were displayed on arbitrary seismic sections, taken through all the wells, for which well to seismic tie was carried out, in order to loop tie the same reservoir top in different wells on seismic. The interpretation is then extended from this known point to other unknown parts of the seismic volume. Based on the seismic to well ties, 19 major horizons were identified and picked, out of which 7 were interpreted across the seismic volume.

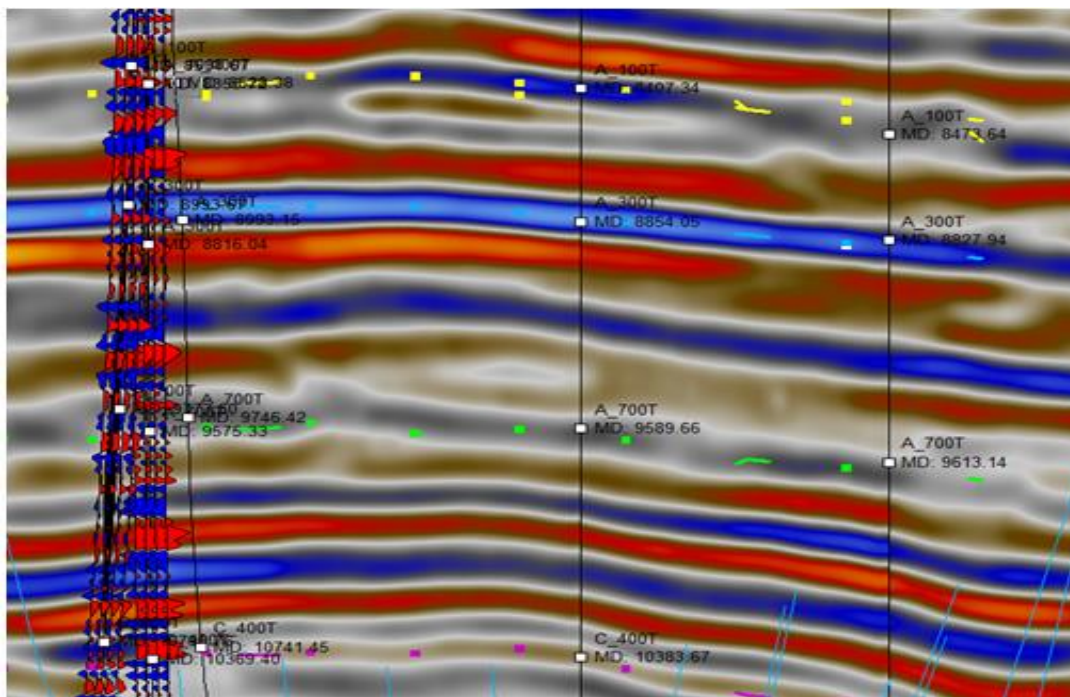


Figure 6: A seismic section showing the well top of a reservoir

One of the major challenges of horizon interpretation is the identification of layers across faults. In this study, this was painstakingly done to avoid mapping the wrong layer across the regional fault. Figure 7 accurately indicates that the reflector mapped at the down thrown section is exactly the continuation of the reflector at the up thrown section.

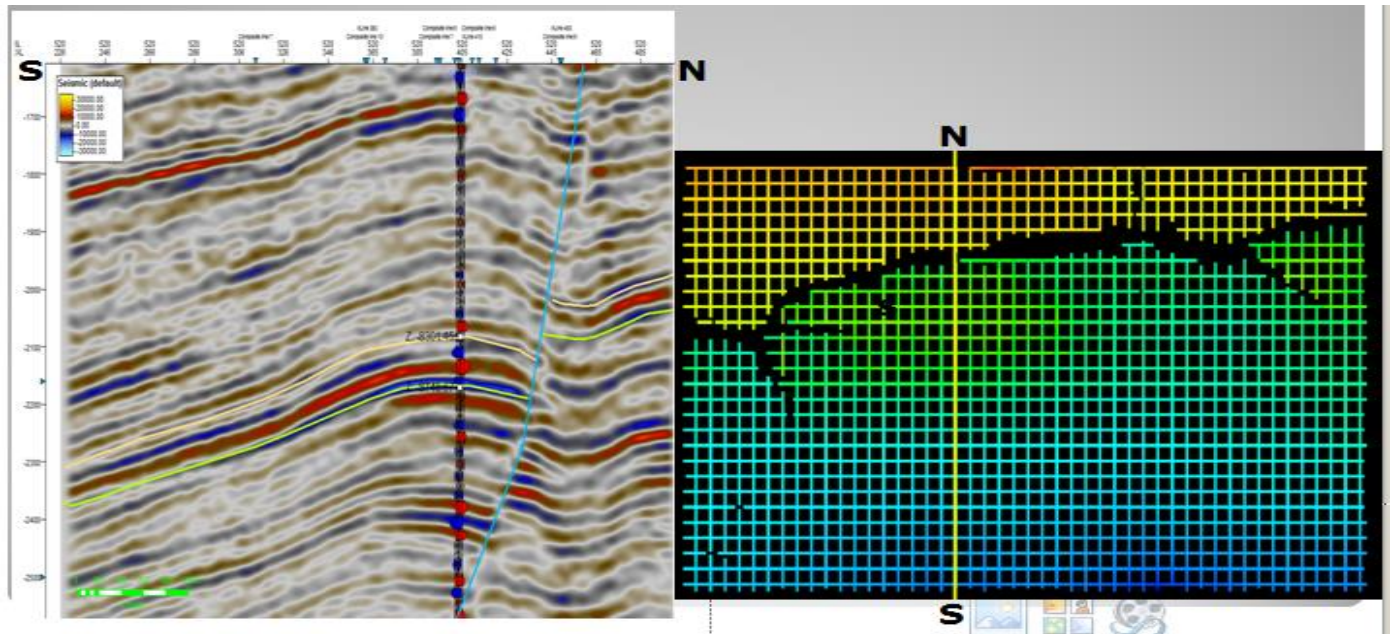


Figure 7: A diagram showing the well top on horizon map in the effort to determine the top of a reservoir.

4.2: Petrophysical analysis

Log correlation²³ involved assigning the sand unit, which was the target reservoir rock across the wells. Similarly, shale lithologies, being the target source rock were correlated across the field (Figure 8). However, it was observed that there exists ‘first sand section’ encountered by the wells, which could not be correlated due to the fact that they are mostly found in a freshwater environment, containing no or less amount of hydrocarbon and hence generally cannot be trapped for economic purposes. Proper correlation begins at the Agbada Formation, with presence of economically viable well-trapped hydrocarbon.

²³ Aaron E. Auduson, Op. Cit

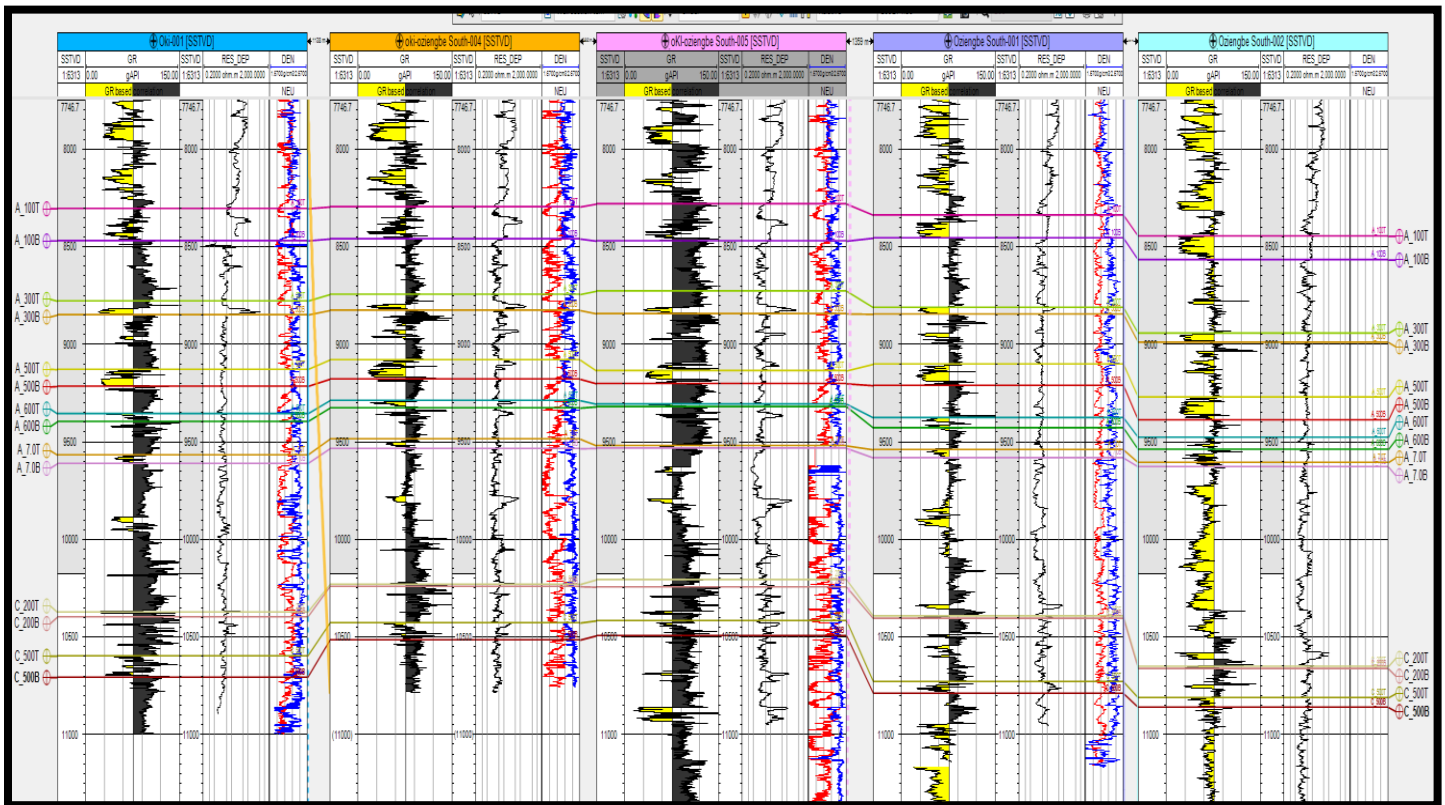


Figure 8: Emakpe-Field correlated wells (Ema-001, Emakpe South 001, Emakpe South 002, Emakpe South 004, and Emakpe South 005) in order from the left to right. The first track of each well contains the Gamma ray log, the second contains the Lateral Deep Resistivity log, and the third track contains both bulk density and neutron logs as composite logs.

4.3 Reservoir Mapping

The seven hydrocarbon-bearing sand units within the Agbada Formation labeled Sand A_100 to A_700 were mapped within the seismic section. Depth conversion was done in order to convert the interpreted seismic horizons from the travel time domain to the depth domain using velocity analysis^{24, 25}. The TVDSS (= displacement) is Plotted against TWT (Time, t), resulting in a velocity model, via the regression line of the plot (Figure 9).

Contour maps indicating the most accurate representation of the subsurface geology of Sand A_100 and A_300 are presented as both time map (Figure 10) and depth maps (Figures 11 and 12). The maps show the four major faults (F1, F2 F3 and F4) that formed the closure responsible for the hydrocarbon accumulation in the Field. The five wells were placed to have been situated to target both oil and gas in the reservoir.

²⁴ Kuut Bjorlykke (2010). Petroleum Geoscience from Sedimentary Environment to Rock Physics:SpringerHeidelberg Dordrecht London New York

²⁵ Ashley Francis (2018). A Simple Guide to Seismic Depth Conversion: Part I, <https://www.geoexplor.com/articles/2018/05/a-simple-guide-to-seismic-depth-conversion-part-i>

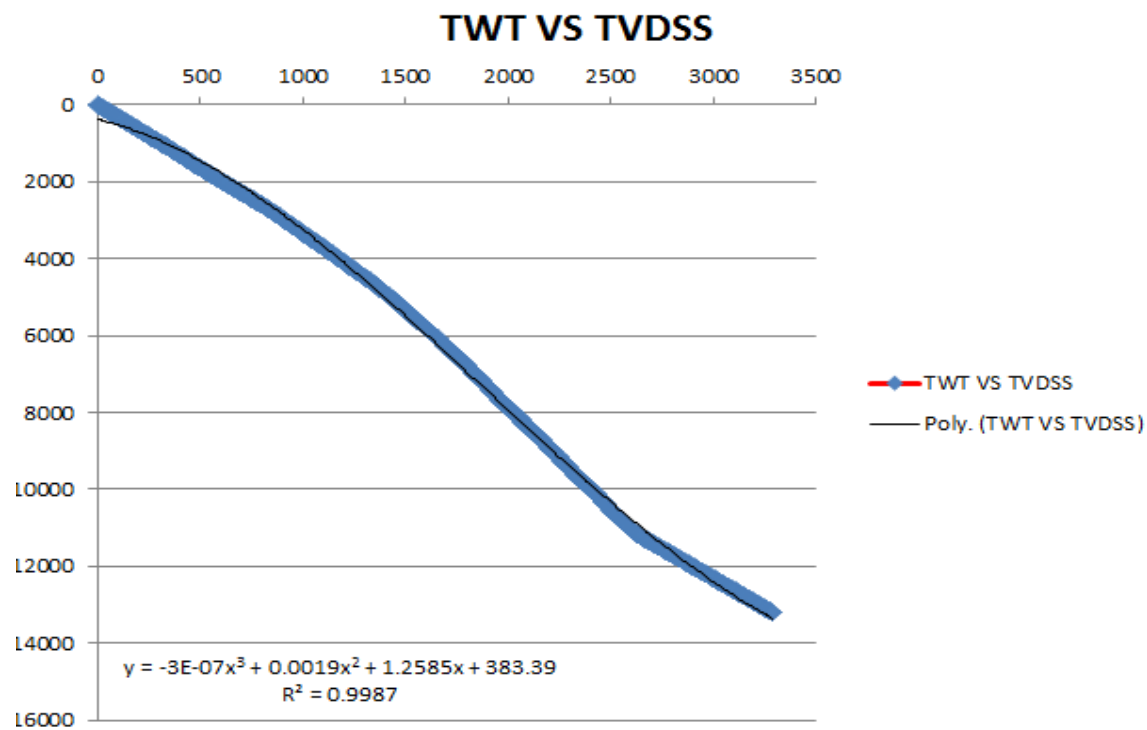


Figure 9: The output of TWT VS TVDSS

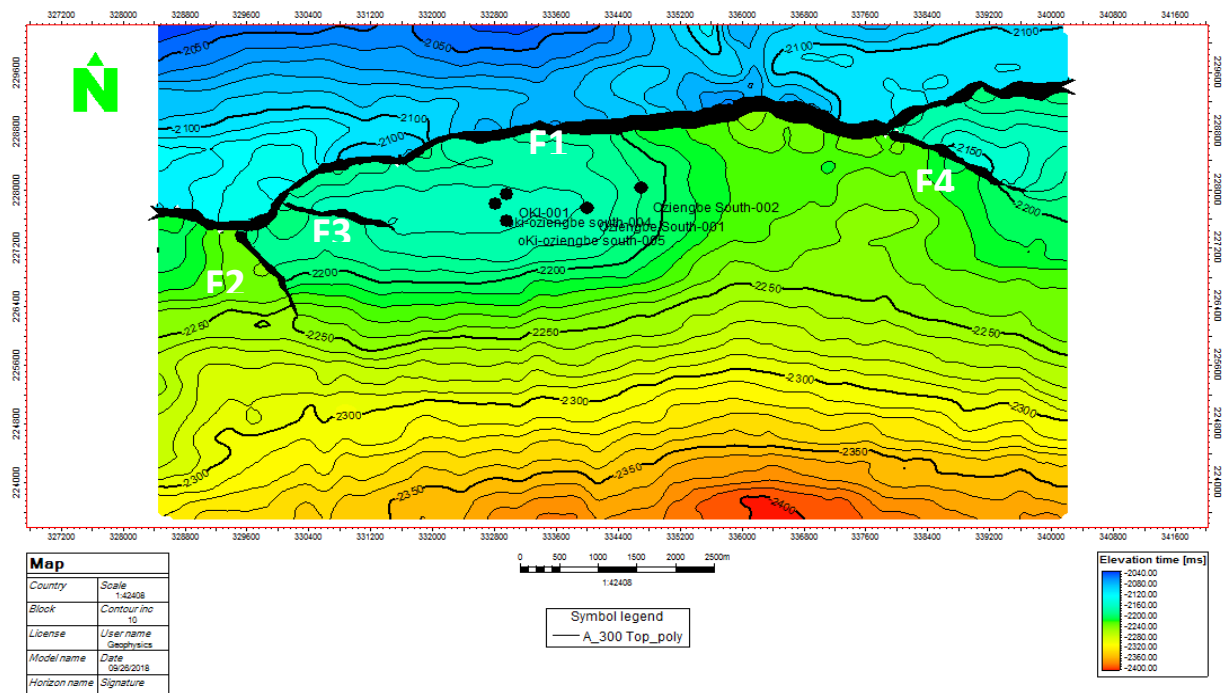


Figure 10: Isochron map at horizon A_300 colour time, showing the four fault polygons (F1, F2, F3 and F4), which provide closure for hydrocarbon entrapment.

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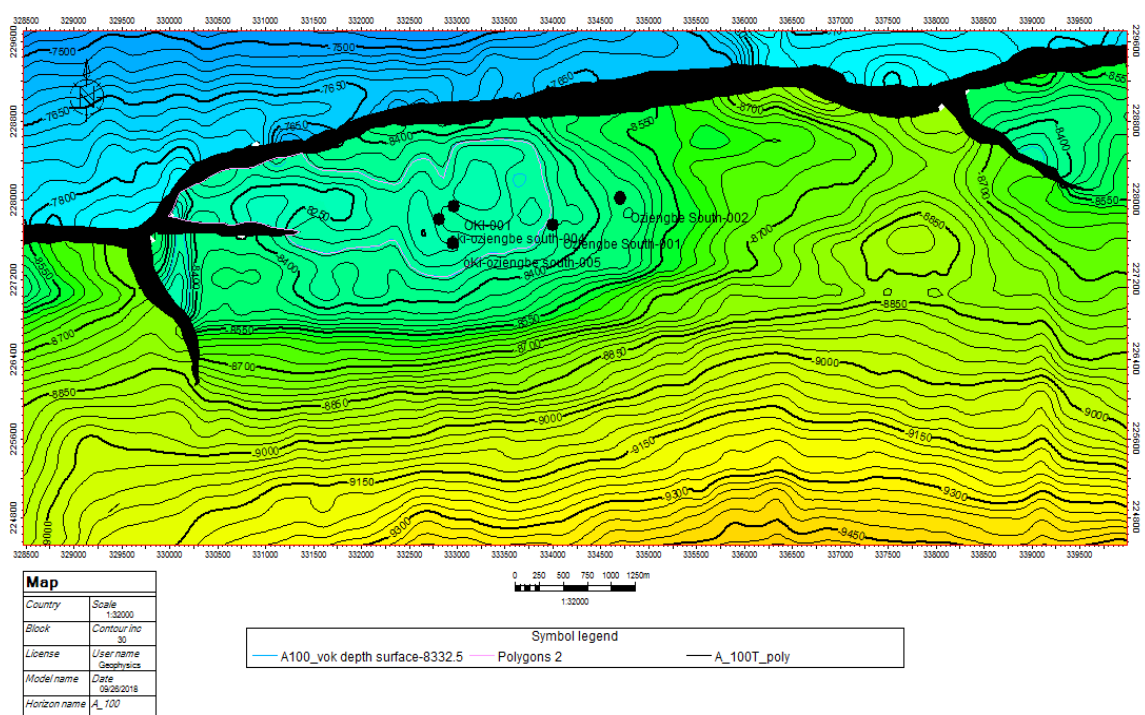


Figure 11: Isopach map at horizon A_100 colour depth, showing the four fault polygons (F1, F2, F3 and F4), which provide closure for hydrocarbon entrapment.

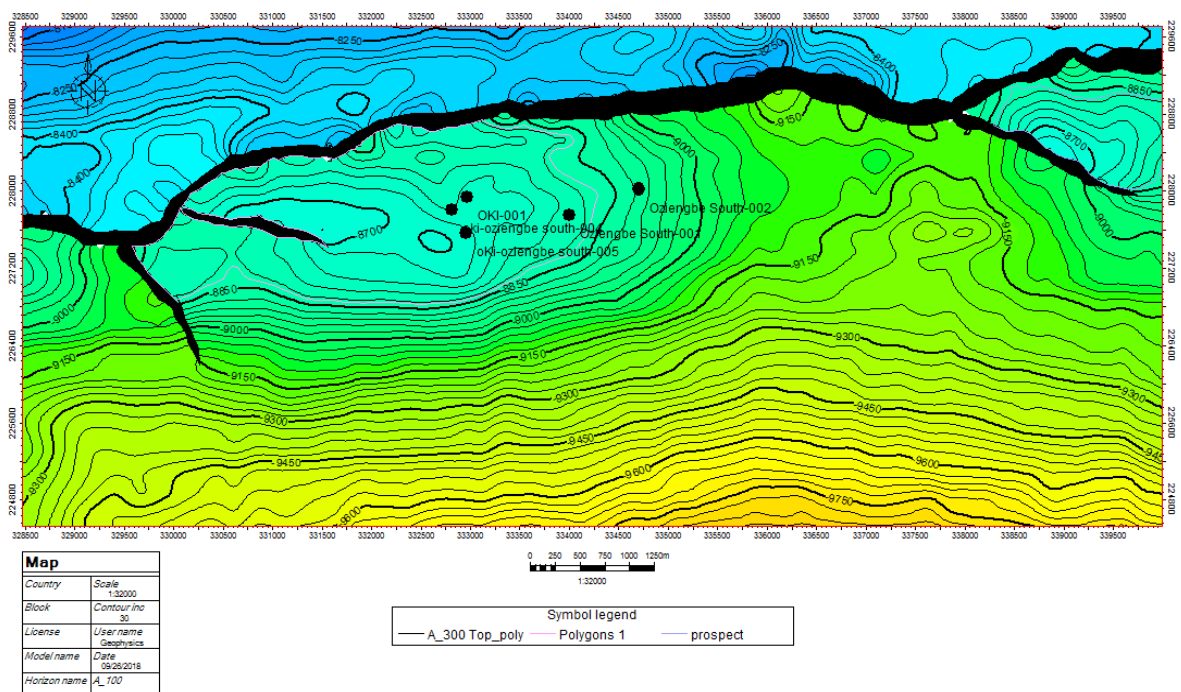


Figure 12: Isopach map at horizon A_300 colour depth, showing the four fault polygons (F1, F2, F3 and F4), which provide closure for hydrocarbon entrapment.

4.4 Reservoir Properties and Contacts

The pay summary of the reservoirs, especially porosity, permeability, charge, as well as trap and seal

properties in the Emakpe Field is as presented in Table 2. The porosity varies from 14% to 21%, with average of 19%, which can be quantitatively rated as very good^{26, 27}. The thickness of the reservoirs shows fairly good sand development and varies laterally, indicating that they are controlled by the growth faults. The permeability is characterized with average of 76-390 mD, while the charge shows good organic content. The water saturation varies from 0.2 to 0.8. The contact depths of the reservoirs after depth conversion are shown in Figures 13-14 and Table 3, while the fluid distributions relative to the contacts are shown in Tables 4 and 5.

Table 2: The pay summary of the reservoirs (A_300 as representative)

S.N	Critical Element	Sub-Element	Score	Description
1	Trap and Seal	Closure volume	0.3	Two-way closure against the synthetic fault is uncertain. This was identified on the seismic
		Seal	0.8	Presence of thick shale layer, as typified in wells and appreciable fault throw
2	Reservoir porosity and permeability	Adequate reservoir thickness	0.6	Fairly good sand development
		Porosity	0.8	A_300 reservoir has an average porosity 19% which is considered very good in porosity range scale of about 14-21% across OML111 field.
		Permeability	0.7	An average of 76-390 permeability (mD) is recorded in OML 111 study field
3	Charge	Charge	1	OML 49 study field indicates a good organic content
		Maturation, time and pressure	1	OML 111 has good sedimentation history leading to discovery
		Migration (source to trap)	1	Viable migration pathway is evident by the syn-depositional fault

²⁶ SEG Wiki (2022). Reservoir Fluid Properties, https://wiki.seg.org/wiki/Reservoir_fluids_properties

²⁷ Etu-Efeotor, J. (1997). Fundamentals of Petroleum Geology, Africana-FEP Publishers, Onitsha, 111-123

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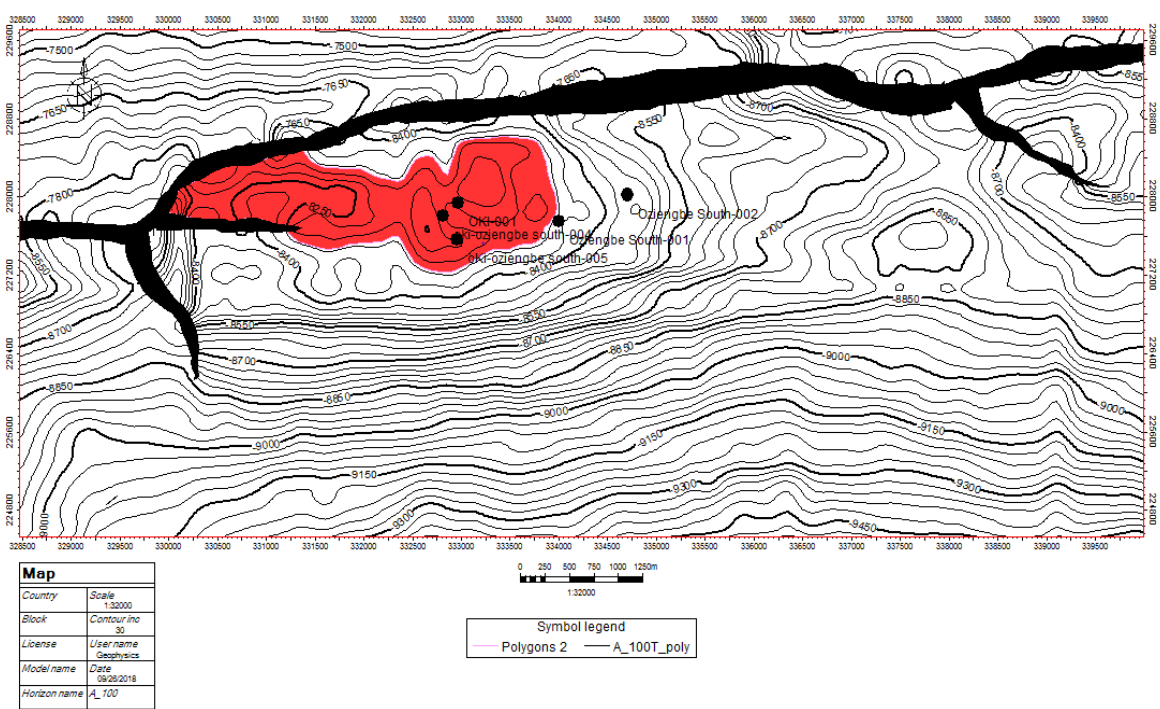


Figure 13: Oil-water contact (OWC) Posted on depth map for reservoir horizon A_100

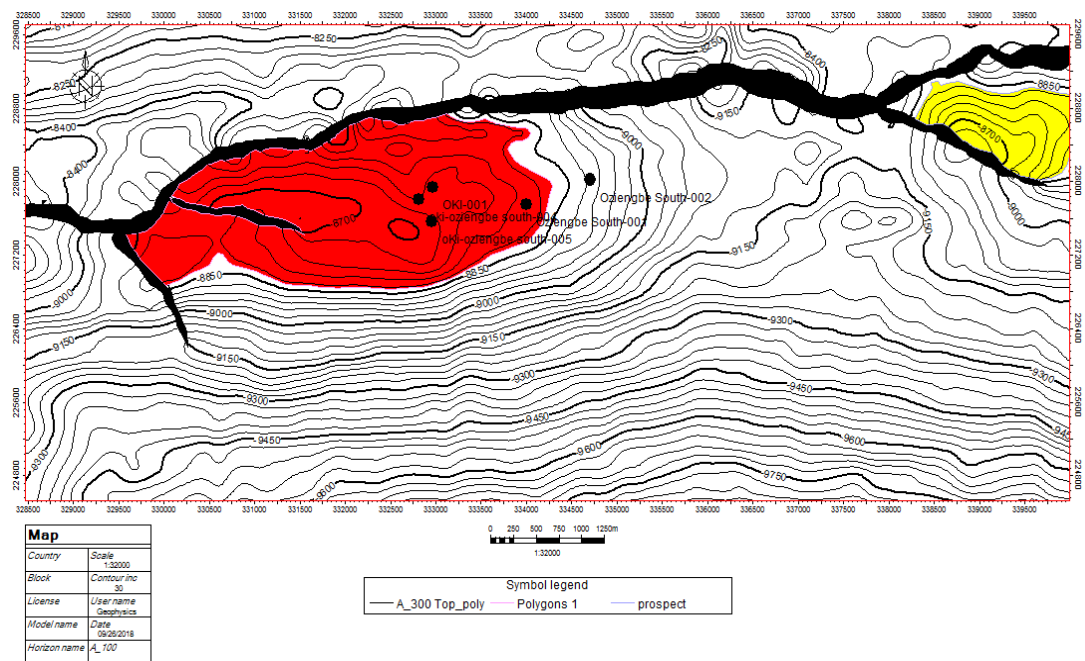
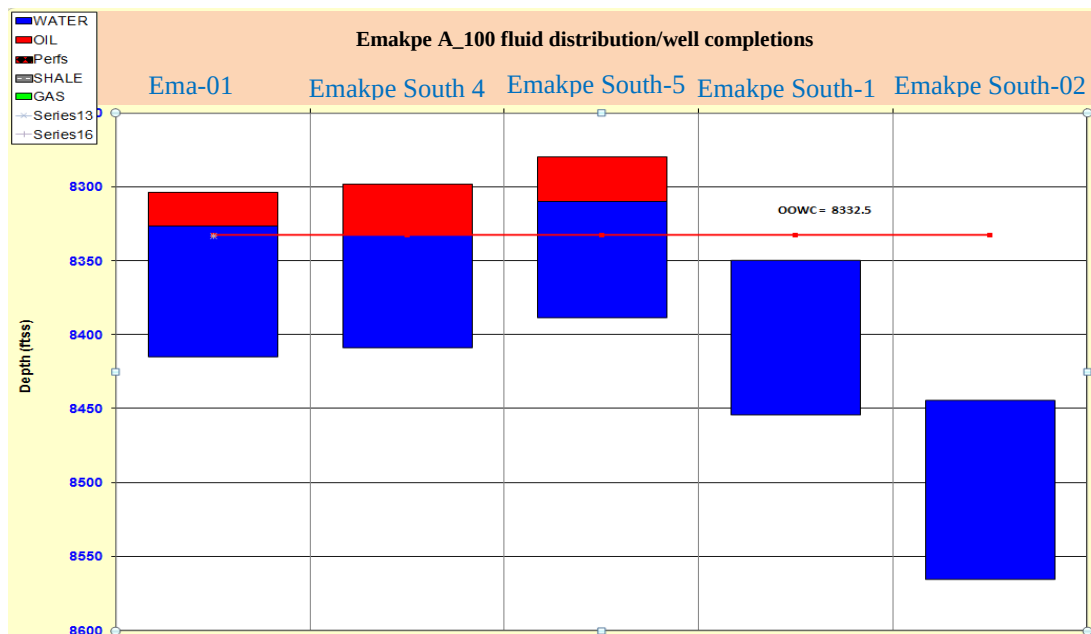
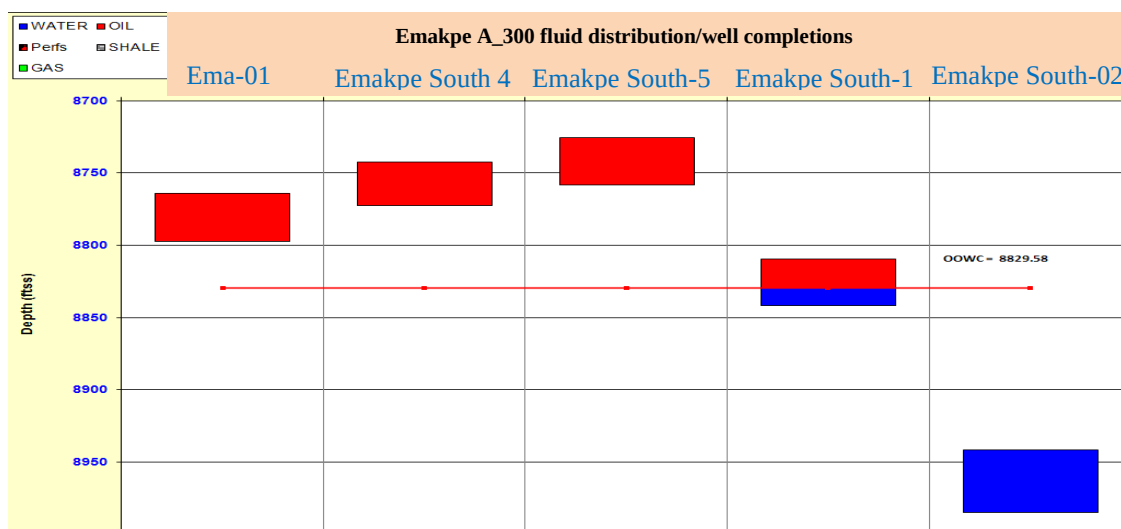


Figure 14: Oil-water contact (OWC) Posted on depth map for reservoir horizon A_300

Table 3 Reservoir contacts depth for A_100 and A_300 reservoirs

Field	Reservoir	Fluid Distribution	Depth ft ss
Emakpe-Field	A-100	OOWC	8332.5
Emakpe -Field	A-300	OOWC	8829.58

Table 3 Reservoir fluid distribution relative to the contacts for A_100 horizon**Table 4:** Reservoir fluid distribution relative to the contacts for A_300 horizon

4.5 Volumetric and Risk Analysis

Using the gross rock volume, net-to-gross, hydrocarbon saturation, porosity within the rocks, and the water saturation parameters, the original oil in place^{28, 29} as calculated for possible amount of hydrocarbon in the reservoir (Equation 1).

$$OOIP = 7758 * (1 - SW) * \phi * NTG * GRV \quad (1)$$

Where,

7758 = Conversion factor into Barrels; Sw = Water saturation; 1-Sw = Hydrocarbon saturation;

NTG = Net to Gross; GRV = Gross Rock Volume;

The volumetric estimates after modelling reservoir horizons A_100 and A_300 are presented in Table 5. Reservoir horizon A_100 has a total gross rock volume of 33744.9, NTG of 0.795, average porosity of 0.17, hydrocarbon saturation of 0.67, while reservoir horizon A_300 has a total gross rock volume of 89550.7, NTG of 0.96925, average porosity of 0.19, hydrocarbon saturation of 0.70. Applying these values for the calculating the OOIP for reservoir horizon A_100 and A_300, 23,705,481.08 barrels and 89,558,376.24 barrels were obtained respectively. Based on the generalized acceptable convention for hydrocarbon volumetric and reserve estimation; a small field contains 10-100 million barrels, a mid-sized field contains 100-500 million barrels, and a giant field has over 500 million barrels. The summation of the hydrocarbon volumes in Emakpe-Field, mounts to a total of 113,263,857.32 barrels (>100 million barrels). On this basis, the Emakpe-Field is classified as a mid-sized field, which indicates commercial hydrocarbon value; therefore, the static model derived from it could be used for simulation and monitoring performance.

Table 5: A table to show for the volume hydrocarbon present in the reservoir

Reservoir	GRV (Acres)	NTG	Av. Phie (ϕ)	Conversion factor (CF)	Hydrocarbon Saturation	Fluid Type	Hydrocarbon volume
A_100	33744.9	0.795	0.17	7758	0.67	Oil	23,705,481.08
A_300	89550.7	0.96925	0.19	7758	0.70	Oil	89,558,376.24

5.0 Conclusion

This work represents analysis of hydrocarbon prospect carried out in the Emakpe-field, in the Northern Depobelt of the Niger Delta Sedimentary Basin. In view of the objective of the study, the available data set inclusive of 3D seismic and well data were integrated.

Well correlation show good match and control the geology of the field, which helped in understanding the reservoir properties at each well location. Extensive seismic data interpretation shows deterministic geologic framework, good stratigraphic model and structural styles of the field. Horizon interpretation show that the Agbada Formation, is the target reservoir, with presence economically viable of hydrocarbon well traps. Fault interpretation shows that the area is characterized with multiple structural style, characteristic of typical Niger Delta Basin.

²⁸ Lisa Dean, (2014). Reservoir Engineering for Geologists Part 3 – Volumetric Estimation, Fekete Associates Inc., Reservoir Issue 11. Pp. 20-21. https://wiki.seg.org/wiki/Reservoir_fluids_properties

²⁹ Tyson, Stephen (2007). An Introduction to Reservoir Modeling, Chippenham: Piper's Ash Ltd, ISBN 978-1-906928-07-0.

Wells to seismic tie show good match between seismic section and well data, implying that interpretation are reliable with high level of confidence. On the basis of the good match observed between the seismic and well data across the field, as well as the extrapolated map and reserves estimation, determination of the volume of hydrocarbon show that good volume (reserve) is present in the field. Using the generalized acceptable convention for hydrocarbon volumetric and reserve field classification, Emakpe-Field, with estimated OOIP value totalling 113,263,857.32 barrels is classified as a mid-sized field. Hence, the Emakpe-Field is economically viable and recommended for investment.

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