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Evaluation of Petrophysical Properties for Lithology and Fluid Discrimination in X- Field using Well log and Seismic Data in Niger Delta

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ABSTRACT

The petrophysical structural modeling was determined to enhance reservoir characterization and fluid discrimination in the X-Field, Niger Delta, by reducing structural uncertainty and delineating hydrocarbon-bearing reservoirs. Key parameters derived from the well log interpretation include Net-to-Gross ratio (NTG), porosity (ϕ), water saturation (Sw), and net pay thickness for each reservoir. These parameters serve as proxies for lithologic heterogeneity, reservoir connectivity, and hydrocarbon saturation. Interpretation of 3-D post-stack seismic data integrated with well logs (gamma ray, resistivity, neutron, density, sonic), well tops, and checkshot data enabled the identification and correlation of two principal reservoirs, RES N and RES O, within the Agbada Formation. The reservoirs are relatively thick, laterally continuous, and demonstrate consistent log signatures across the correlated wells, implying a high degree of connectivity and uniform depositional conditions. The correlation was carried out along a west–east transect comprising six wells arranged in the following sequence: SAM 1, SAM 3, SAM 6, SAM 2, SAM 5, and SAM 4. This alignment was chosen to reflect the structural and depositional trend of the field, which is consistent with the regional structural orientation of the Niger Delta.

Keywords: *Porosity, permeability, water saturation, hydrocarbon saturation and reservoir connectivity*

1. INTRODUCTION

Geophysical well logging involves the measurement of the physical properties of the surrounding rocks with a sensor located in the borehole. The record of the measurement as a function of depth is called a well log (Ebong *et al.*, 2020). In well logs tool is inserted in the borehole and the properties of the rock are measured. The properties measured or computed fall into three broad categories such as conventional petrophysical properties, rock mechanical properties and ore quality. Borehole geophysics is used in ground-water and environmental investigations to obtain information on well construction, rock lithology and fractures, permeability and porosity, and water quality.

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Seismic attributes are very useful tools for reservoir characterization and prospect evaluation because they enhance visibility of features that are below the resolution of seismic data (Lawson & Balogun 2023). Seismic attribute is any measurable physical parameters inherent in seismic reflection data. Seismic attributes is important because it had been utilised as a veritable tool to define the reservoirs.

Seismic attribute analysis has demonstrated the ability to enhance the detection of depositional features, fluid indicators, and fault–fracture networks by transforming seismic reflection data into more interpretable quantitative measures (Ebong et al. 2023; Brown, 2011; Chopra & Marfurt, 2005). However, in the X- Field, a systematic integration of multi-attribute analysis with well data for the purpose of lithology and fluid discrimination will be carry out within the study area.

2. The Study Area

The X- Field is located within shallow offshore portion of the Niger Delta Basin, Nigeria. The Niger Delta is located in southern Nigeria, bordering the Gulf of Guinea in the Atlantic Ocean (Attai et al. 2025). It covers an area of approximately 70,000 square kilometers. It lies approximately between latitudes 3°N and 6°N and longitudes 2°E and 9°E as in Figure 1.

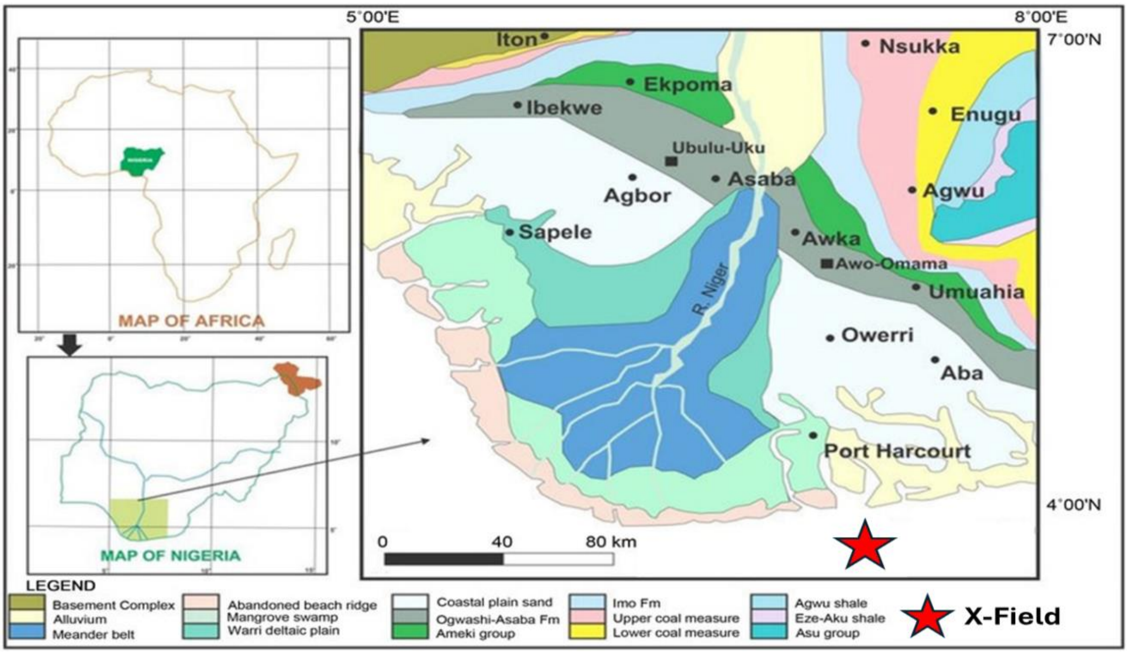

Figure 1: Map of the Niger Delta basin showing location of X-field (After Fagbemigun et al.., 2024; Ebong et al. 2026)

3. MATERIALS AND METHOD

3.1 Materials: Data sets from "X" field were obtained from an oil producing company in the Niger Delta. The dataset available for this study includes: 3D Seismic data (Soft), Well deviation survey data (Soft), Checkshot survey data (in one well), Digital wireline log data (Soft) and Formation tops files

3D Seismic Data: The field is fully covered by a fair to good quality 3D seismic dataset, providing adequate spatial and temporal resolution for structural and stratigraphic interpretation across most of the survey area. The seismic volume offers reliable imaging of the shallow to intermediate subsurface horizons, allowing for effective delineation of major structural features, fault geometries, and potential reservoir intervals. However, the data quality noticeably deteriorates at greater depths due to signal attenuation, loss of high-frequency components, and reduced signal-to-noise ratio. These factors can be attributed to increasing compaction, higher acoustic impedance contrasts, and energy absorption by overlying lithologies, which collectively degrade the seismic resolution with depth (Sheriff & Geldart, 1995; Brown, 2011). Consequently, deeper reflectors appear less continuous and more difficult to interpret with precision, leading to uncertainties in reservoir characterization and structural mapping at those levels. To mitigate this limitation, seismic attribute enhancement, reprocessing with advanced noise suppression techniques, and integration with well log and velocity data are often recommended to improve subsurface imaging and interpretive accuracy (Chopra & Marfurt, 2007; Yilmaz, 2001).

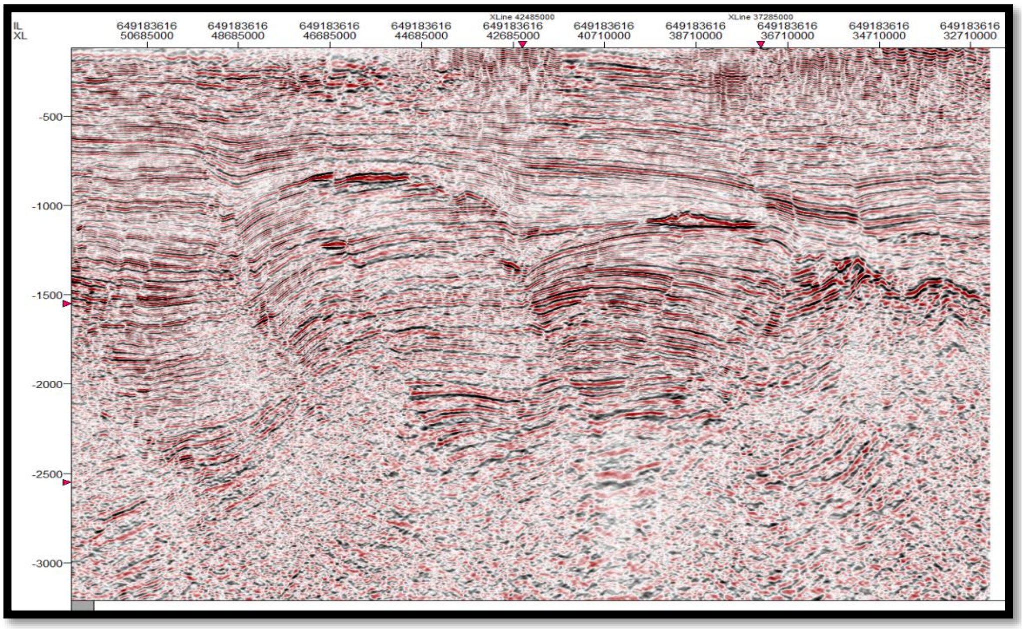

Figure 2: Display of available 3D Seismic (inline 649183616)

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Well Deviation Data: Deviation survey data from the six (6) wells (each of which penetrated Reservoirs N and O) were available for this study. These data are essential for determining the true spatial position of each wellbore and for assessing whether a well is vertical, directional, or highly deviated. The deviation survey provides measurements of well inclination and azimuth at various depths, allowing for the reconstruction of the true vertical depth (TVD) and accurate well trajectory mapping (Ebong et al., 2023a; Ebong et al., 2023b and Schlumberger, 2012). Accurate deviation data are critical for seismic-to-well tie, structural mapping, and correlation of reservoir intervals across the field. In the absence of such corrections, apparent depth discrepancies and misalignment of subsurface features could introduce significant errors in reservoir geometry and volumetric estimations

Checkshot Data: Checkshot velocity data were acquired in only one (1) of the six (6) wells within the field. These data provide a direct measurement of the true seismic travel time from the surface to specific depths in the wellbore, enabling accurate time–depth conversion. The available checkshot survey served as a crucial calibration tool for establishing a reliable seismic-to-well tie during the horizon interpretation stage. By comparing the measured checkshot times with synthetic seismograms generated from well log data, a more precise correlation between seismic reflections and subsurface lithologic boundaries was achieved (Sheriff & Geldart, 1995; Brown, 2011).

Although only one well had checkshot data, it provided a representative velocity profile that was extrapolated across the study area, with necessary adjustments guided by available sonic log data and seismic velocity models. The incorporation of this checkshot information significantly improved the accuracy of horizon picking and depth conversion, thereby enhancing the structural and stratigraphic interpretation of the seismic dataset (Yilmaz, 2001).

Formation Tops Files: The tops and bases of the identified reservoir intervals were available in most of the well files, providing essential stratigraphic control for this study. However, some wells lacked complete reservoir top and base information. These data served as crucial reference points for guiding the interpretation and picking of corresponding reservoir horizons on seismic sections. By correlating known reservoir tops and bases from well control points with reflection events on the seismic data, a consistent stratigraphic framework was established across the field. In wells where such information was missing, tops and bases were inferred through log correlation and tied to nearby wells with similar lithological and petrophysical characteristics, ensuring continuity and interpretive accuracy.

Well Log Data: Log data were available for all six (6) wells within the field, and the overall data quality was considered good for quantitative interpretation and petrophysical evaluation. Table 1 presents the log data availability summary for the X- field. All six wells were drilled using water-based mud, which generally enhances borehole stability and facilitates effective log data acquisition by minimizing invasion effects compared to

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oil-based mud systems (Ebong et al., 2023a; Ebong et al., 2023b and Asquith & Krygowski, 2004).

The primary log suites utilized for quantitative analysis in this study include the Gamma Ray (GR), Resistivity, Density, and Neutron logs. The Gamma Ray log was employed for lithological differentiation and shale volume estimation, while the Resistivity log provided information on fluid saturation and hydrocarbon-bearing zones. The Density and Neutron logs were integrated to evaluate porosity and lithology, as their combined interpretation helps distinguish between gas, oil, and water zones.

In addition, the Spontaneous Potential (SP) and Caliper logs were used qualitatively for lithology identification and borehole condition assessment, respectively. The SP log aided in correlating permeable formations and identifying formation boundaries, while the Caliper log was used to detect hole washouts or irregularities that could affect the accuracy of other log responses (Ebong et al.., 2021 and Schlumberger, 2012). It is important to note that three of the wells (SAM -3, SAM -5 and SAM-6) lack sonic log data. This absence limited direct velocity calibration for time–depth conversion and synthetic seismogram generation in those wells; however, available checkshot and nearby well sonic data were used to compensate for this gap through correlation and interpolation methods.

Table 1: Summary of the field well logs

Well	GR	RES	DEN	NEU	SONIC	CALI	SP
SAM_1	x	x	x	x	x	x	x
SAM_2	x	x	x	x	x		
SAM_3	x	x	x	x		x	x
SAM_4	x	x	x	x	x		x
SAM_5	x	x	x	x		x	
SAM_6	x	x	x	x		x	x

KEY
X Log Available
Log not Available

Tools/Applications Employed: Petrel 2014 (a Schlumberger software suite) was employed for the geological and geophysical interpretation in this study. Petrel provides an integrated platform that supports seismic interpretation, well correlation, structural modeling, and reservoir characterization workflows. It facilitated the visualization and integration of seismic and well data, allowing for efficient seismic-to-well ties, horizon and fault mapping, and 3D geological model construction (Schlumberger, 2012). Interactive Petrophysics (IP) software was used for petrophysical interpretation and quantitative analysis of well log data. The software's robust suite of tools enabled environmental corrections, log normalization, lithology identification, and the derivation of key reservoir parameters such as shale volume, porosity, water saturation, and permeability. IP's crossplot and multi-well correlation capabilities were instrumental in quality control and comparative analysis across the six wells.

Microsoft Excel was utilized for data management, statistical evaluation, and graphical analysis. It was particularly useful for organizing input datasets, computing derived parameters, and generating crossplots and histograms that complemented petrophysical interpretations. The combination of these software tools ensured a comprehensive and integrated workflow, from data preprocessing through geological modeling to reservoir evaluation.

3.2 METHOD

Data Loading: Data loading was the first step in this study and was carried out using Petrel 2014 software. A new Petrel project was created, and the coordinate reference system (CRS) corresponding to the study area was defined to ensure spatial alignment of all datasets. The 3D seismic dataset (SEG-Y format) was imported through the *Input pane*, specifying inline and crossline ranges, sampling interval, and trace length according to the survey parameters. Quality control checks were performed to confirm correct orientation, polarity, and spatial coverage of the seismic cube. Well data**,** including well headers, deviation surveys, check-shot data, and log curves (in LAS format), were then loaded. The well header defined the well location, deviation surveys established well trajectories, and check-shot data were used for time-depth calibration**.** Log curves such as gamma ray, density, neutron, resistivity, and sonic were imported and verified for depth consistency. After loading, wells were displayed on the base map and seismic section to confirm proper alignment between the seismic and well data. Structural markers, such as faults and horizons, were also imported as XYZ or ASCII files for later use in interpretation and attribute analysis.

Well Normalization: Well normalization was performed to standardize the log data from all wells, ensuring consistency and ease of comparison during petrophysical and geological interpretation. The process involved adjusting the log scales and visual formats to a common reference system so that all wells could be accurately compared within the Petrel and Interactive Petrophysics (IP) environments. This step was essential to eliminate inconsistencies arising from differences in logging conditions, measurement ranges, and operational parameters. Each well log was scaled to an appropriate and

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uniform range: gamma ray (1–150 API)**,** resistivity (0.2–2000 Ωm)**,** density (1.65–2.65 g/cc)**,** neutron porosity (0–0.6 fraction)**,** and sonic (40–140 µs/ft)**.** Distinct color codes were assigned to each log track for clear visualization and interpretation. This uniform presentation facilitated quick cross-well comparison, improved correlation accuracy, and enhanced interpretation of lithologic and reservoir properties across the field.

Reservoir Identification/Well Correlation: Reservoir identification and correlation were carried out to establish the lateral and vertical continuity of the reservoir units across the field. The process involved the integration of well log data, formation tops, and lithologic information to delineate the main reservoir intervals and understand their spatial distribution. The gamma ray (GR), resistivity (RT), density (RHOB), neutron (NPHI), and sonic (DT) logs were used as the primary tools for reservoir delineation. The gamma ray log was employed to distinguish between shale and sand lithologies, where low GR readings indicated clean sands, while high readings corresponded to shale intervals. The **resistivity** log was used to identify hydrocarbon-bearing zones based on zones of anomalously high resistivity relative to adjacent water-bearing sands. The density and neutron logs were combined on crossplots to differentiate between gas-, oil, and water-bearing intervals, as well as to infer lithology and porosity variations. Wells were arranged according to their spatial positions, and the reservoir markers were correlated laterally to establish stratigraphic continuity and structural configuration across the field. This correlation revealed the presence of continuous sand bodies in some areas and localized thickness variations in others, which were interpreted as indicators of structural control and depositional variability. Reservoir tops and bases were picked for each well by visually correlating consistent log signatures and supported by available formation top markers**.** The identified reservoirs were labelled Reservoir N (RES N) and Reservoir O (RES O)**,** consistent with field conventions. The correlation panels were color-coded to highlight key lithological changes and reservoir boundaries, aiding in the visualization of sand–shale alternations and the delineation of potential hydrocarbon zones. The results provided the framework for subsequent seismic-to-well tie and horizon interpretation**.**

Petrophysical Analysis: Petrophysical analysis was conducted to quantitatively evaluate the reservoir characteristics of the identified sand units and to determine their hydrocarbon potential. The analysis was performed using Interactive Petrophysics (IP) software, with supplementary data management and computation in Microsoft Excel. The workflow included data quality control, lithology and shale volume determination, porosity analysis, resistivity and formation factor computation, water and hydrocarbon saturation estimation, and thickness analysis (gross and net).

Lithology and Shale Volume Determination: Lithology identification was primarily based on the gamma ray log, which distinguishes between clean sands and shales. The Volume of Shale (Vsh) was computed using the tertiary rock correction equation, appropriate for the Niger Delta:

$$I_{GR} = \frac{GR_{log} - GR_{min}}{GR_{max} - GR_{min}} \quad (1)$$

$$V_{sh} = 0.083 \times (2^{3.7 \times IGR} - 1) \quad (2)$$

Where:

GR_{log}= gamma ray reading of the formation,
GR_{min}= minimum gamma ray in clean sand, and
GR_{max}= maximum gamma ray in shale.

This parameter served as a basis for identifying clean and shaly intervals and for shale correction in porosity and saturation computations (Asquith & Krygowski, 2004).

Gross and Net Sand Thickness: Gross thickness was defined as the total vertical interval between the top and base of each identified reservoir unit, as interpreted from well logs and formation markers. This was measured directly from the gamma ray and resistivity logs, encompassing both pay and non-pay sections. Net thickness**,** on the other hand, represented the portion of the gross interval that met reservoir quality criteria. The following cut-off parameters were applied to define net pay: Gamma Ray (GR) ≤ 75 API (clean sand), Effective Porosity (ϕeff) ≥ 0.10 and Water Saturation (Sw) ≤ 0.60.
Net pay zones were identified and measured using these cut-offs, and the Net-to-Gross (N/G) ratio was computed as:

$$N/G = \frac{h_{net}}{h_{gross}} \quad (3).$$

Where: h_{net}= total thickness of net sand and
h_{gross}= total gross reservoir thickness.

Porosity: Porosity is the proportion of a given volume of rock that forms pore space and can thus hold liquid (Ekanam & Ebong 2025 and Schlumberger, 2012). It is the fractional volume of pores in a rock, a relative quantity that is often expressed in decimal/fractional units or as a percentage. This volume of voids is useful for storing fluids like water, oil, and gas; if permeable, it may also transport these fluids to a lower-pressure zone. Porosity was derived from both density logs. The density-derived porosity (ϕD) was calculated using the equation:

$$\emptyset_D = \frac{\rho_{ma} - \rho_b}{\rho_{ma} - \rho_f} \quad (4)$$

Where: ρ_{mat} = Density of Rock Matrix (2.65g/cc for sandstone),
ρ_{bulk} = Bulk Density and ρ_{fluid} = Fluid Density (1.0 g/cc for water)

Water Saturation: Water saturation (Sw) is a crucial petrophysical parameter in reservoir characterization, representing the fraction of pore space in a rock that is occupied by formation water (Attai et. al., 2015 and Ekanem & Ebong2026). It is critical for determining hydrocarbon saturation (Sh), volumetric reserves, and production potential. Accurate estimation of Sw is essential for evaluating reservoir quality and planning hydrocarbon extraction. Water saturation (Sw) was computed using the Archie equation (1942):

$$S_w^n = \frac{a \times R_w}{\emptyset^m \times R_t} \quad (5)$$

Where: S_w= water saturation,
R_w= formation water resistivity,
R_t= true formation resistivity,
n= saturation exponent (usually 2),
a and m are constants as previously defined.

Hydrocarbon saturation (Sh) was then derived as:

$$S_h = 1 - S_w \quad (6)$$

These calculations enabled quantitative evaluation of hydrocarbon-bearing zones across all wells.

Permeability: Permeability (k) measures the ability of a rock to transmit fluids, which is vital for evaluating reservoir performance. Direct measurement from core samples is ideal, but in their absence, empirical correlations are used. Alternatively, Timur's Equation provides estimation:

$$k = 0.136 \times \emptyset^4 \times S_{wirr}^{-2} \quad (7)$$

where: S_{wirr}: Irreducible water saturation and $\emptyset$: Porosity

These models offer a means to estimate permeability when core data is unavailable, though they should be calibrated with local data for accuracy (Asquith & Krygowski, 2004).

Formation Factor (F) Determination: The formation factor (F), which relates rock porosity to its electrical resistivity in the absence of hydrocarbons, was determined using Archie's empirical relationship (Archie, 1942):

$$F = \frac{a}{\phi^m} \quad (8)$$

where: F= formation factor,
a= tortuosity constant (commonly 1.0 for clean sands),
ϕ= porosity (fractional), and
m= cementation exponent (typically 2.0 for consolidated sandstones).

4. RESULTS

Well Correlation: Well correlation was undertaken to establish the lateral and vertical continuity of hydrocarbon-bearing sand units across the X- Field. This exercise serves as a fundamental step in subsurface geological interpretation, enabling the delineation of reservoir architecture, stratigraphic relationships, and the spatial distribution of productive zones within the field. From the correlation panel (Figure 3), two prominent sand intervals within the Agbada Formation were identified and designated as Reservoirs N and O.

The well correlation confirms that Reservoirs N and O are stratigraphically consistent and laterally connected, forming the principal hydrocarbon-bearing zones within the X- Field. These results provide a strong framework for subsequent interpretation of structural configuration, petrophysical evaluation, and seismic attribute ~~analysis~~ aimed at characterizing reservoir geometry and assessing hydrocarbon potential.

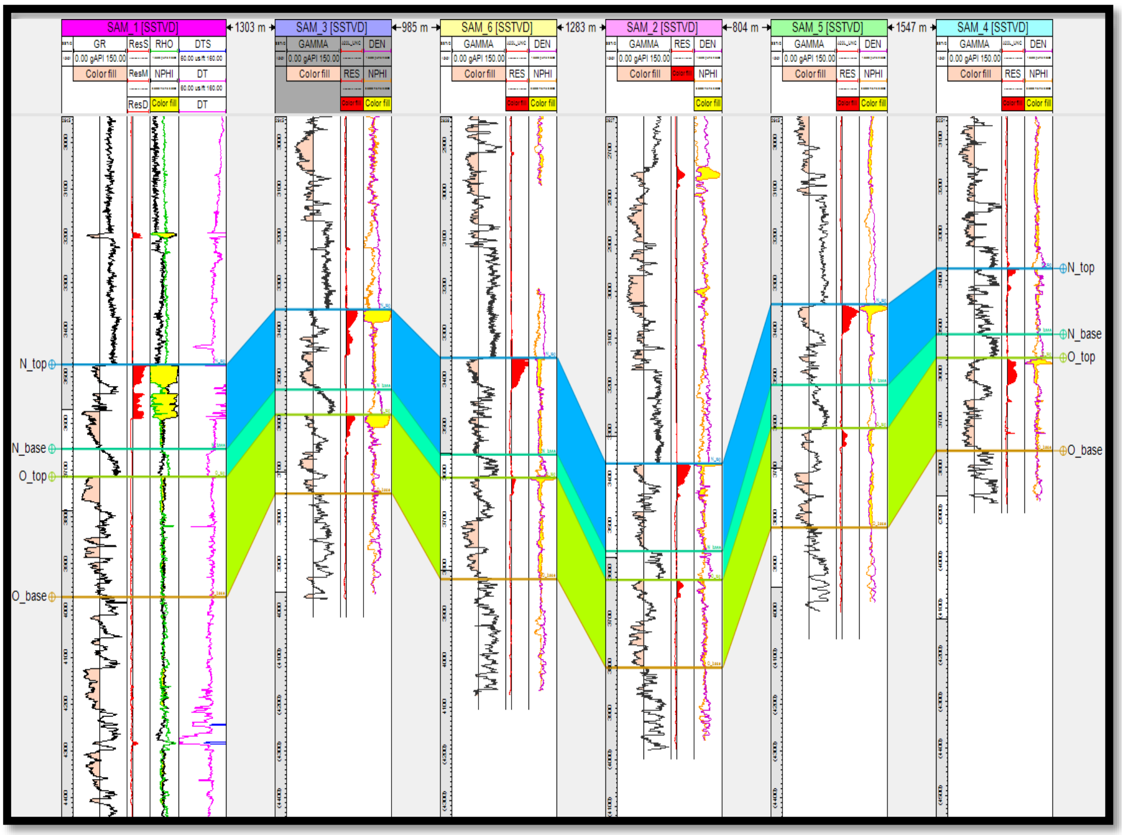

Figure 3: Well correlation of hydrocarbon bearing sand across wells in the "X"- field. (Large resistivity spikes indicate presence of hydrocarbon

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Petrophysical Evaluation: Petrophysical analysis was conducted on six wells (SAM 1 – SAM 6) within the X- Field to quantify key reservoir properties, including Net-to-Gross ratio (NTG), porosity (ϕ), and water saturation (Sw) for the identified reservoir units, Reservoir N and Reservoir O, within the Agbada Formation. These parameters revealed the quality and hydrocarbon-bearing potential of the reservoirs which was used as critical inputs for volumetric and reservoir characterization studies.

Petrophysical Results for Reservoir N: The computed petrophysical parameters for Reservoir N are presented in Table 2, while the corresponding net pay results are summarized in Table 3. The Net-to-Gross (NTG) ratio for Reservoir N ranges from 0.67 to 0.78, with an average value of approximately 0.74 across the field. The highest NTG values occur in SAM 5 and SAM 6 (0.78), indicating well-developed, laterally continuous sand bodies with minimal shale intercalations. The lowest value of 0.67 observed in SAM 4 suggests moderate shaliness, possibly reflecting localized depositional variability or the influence of structural compartmentalization along fault trends. The generally high NTG values across the field demonstrate excellent reservoir sand development typical of the paralic Agbada sequence.

Porosity values for Reservoir N range from 0.22 to 0.28, averaging approximately 0.25, which indicates moderately good reservoir quality. The highest porosity of 0.28 in SAM 1 corresponds to a cleaner, coarser-grained sandstone interval, while lower porosity values (0.22–0.23) in SAM 3 and SAM 4 may be attributed to increased clay content or compaction effects in structurally deeper zones. These porosity values are consistent with typical deltaic sandstones of the Niger Delta, where intergranular porosity is the dominant pore type.

Water saturation (Sw) ranges between 0.08 and 0.23, averaging approximately 0.15, which implies low water content and a high hydrocarbon saturation potential across the reservoir. The lowest Sw value of 0.08 in SAM 2 indicates high hydrocarbon saturation and excellent reservoir potential, whereas higher values (>0.20) in SAM 5 and SAM 6 may reflect partial water invasion or reduced hydrocarbon saturation along the flanks of the structure.

The net pay analysis (Table 3) reveals variable hydrocarbon distribution within the reservoir. The gas pay thickness ranges from 0 to 115 ft, while oil pay thickness varies between 50 and 74 ft. SAM 1 exhibits the thickest gas pay (115 ft), suggesting that it is positioned close to a structural crest where gas cap accumulation occurs. In contrast, SAM 2 - SAM 6 shows predominantly oil-bearing intervals with minor or no gas contribution, consistent with a gas-over-oil contact relationship typical of rollover structures.

Summarily, the petrophysical evaluation indicates that Reservoir N is a high-quality reservoir characterized by good sand development, moderate porosity, and low water saturation. The spatial variation in hydrocarbon type (gas in SAM 1, oil in SAM 2 - SAM 6) reflects structural control on hydrocarbon distribution, confirming the role of fault-assisted traps and structural closures as the dominant entrapment mechanisms within the X- Field.

Table 2: Petrophysical parameters for Reservoir N (NTG, Porosity, Sw).

Well	SAM 1	SAM 2	SAM 3	SAM 4	SAM 5	SAM 6
NTG	0.7	0.75	0.75	0.67	0.78	0.78
Porosity	0.28	0.25	0.22	0.23	0.27	0.24
Sw	0.1	0.08	0.13	0.14	0.22	0.23

Table 3: Net pay summary for Reservoir N (Gas and Oil pay thickness)

Well	Gas pay thickness	Oil pay Thickness
SAM 1	115	0
SAM 2	28	69
SAM 3	0	64
SAM 4	8	74
SAM 5	15	50
SAM 6	0	58

Petrophysical Results for Reservoir O: The petrophysical results for Reservoir O are summarized in Table 4 with corresponding net pay data presented in Table 5. The Net-to-Gross (NTG) ratio for Reservoir O varies from 0.51 to 0.96, averaging approximately 0.78. The highest NTG value of 0.96 in SAM 4 signifies excellent sand development and minimal shale interbedding, while the lowest value of 0.51 in SAM 2 suggests a more heterogeneous lithologic composition, possibly due to distal depositional influence or structural juxtaposition against shale faeces.

Porosity values range from 0.21 to 0.27, averaging 0.23, indicating moderately good reservoir quality comparable to that of Reservoir N. The highest porosity value of 0.27 observed in SAM 4 suggests clean, well-sorted sands at shallower depths, while lower porosity values (0.21–0.22) in SAM 2, SAM 3, and SAM 5 may result from compaction or cementation effects in deeper or fault-bounded zones.

Water saturation (Sw) varies widely between 0.0 and 0.30, with an average of 0.17. The lowest water saturation in SAM 1 (0.0) and SAM 6 (0.10) implies very high hydrocarbon saturation, while higher values in SAM 3 (0.30) and SAM 4 (0.27) may reflect proximity to transition zones or residual water in low-permeability sections.

The net pay analysis (Table 5) shows that the gas pay thickness ranges from 0 to 28 ft, while oil pay thickness varies significantly between 0 and 81 ft. The most significant oil pay is recorded in SAM 6 (81 ft) and SAM 4 (40 ft), confirming that the main hydrocarbon accumulations occur within the downthrown fault blocks where structural closures are well defined. The limited gas pay in most wells suggests that gas caps are either localized or thin, possibly due to spill points or differential trapping.

The petrophysical trends indicate that Reservoir O exhibits slightly higher sand development but marginally lower porosity than Reservoir N. The reservoir demonstrates a mixed hydrocarbon phase, predominantly oil-bearing, with gas occurrences confined to structural crests and closure edges. The consistency of low Sw values and high NTG across the wells points to good reservoir continuity and effective sealing by overlying shale units.

Table 4: Petrophysical parameters for Reservoir O (NTG, Porosity, Sw).

Well	SAM 1	SAM 2	SAM 3	SAM 4	SAM 5	SAM 6
NTG	0.67	0.51	0.78	0.96	0.8	0.78
Porosity	0.27	0.21	0.22	0.27	0.21	0.22
Sw	0	0.16	0.3	0.27	0.2	0.1

Table 5: Net pay summary for Reservoir O (Gas and Oil pay thickness)

WELL	Gas pay thickness	Oil pay thickness
SAM 1	0	0
SAM 2	28	22
SAM 3	12	30
SAM 4	0	40
SAM 5	0	37
SAM 6	15	81

5. DISCUSSION

This study presents an integrated geophysical and petrophysical evaluation of the X-Field, located within Niger Delta Basin. The integration of well log and seismic data provided a comprehensive understanding of the lithologic composition, structural configuration, reservoir quality, and hydrocarbon prospectivity of the field.

The research was guided by the objectives of identifying and characterizing hydrocarbon-bearing reservoirs, delineating their structural and stratigraphic settings. Two key sandstone reservoirs - Reservoir N and Reservoir O -were delineated and analyzed across six wells (SAM 1 – SAM 6). Petrophysical analysis revealed that both reservoirs are well-developed, laterally continuous, and hydrocarbon-bearing, with high net-to-gross ratios and moderate to high porosity. Reservoir N exhibited superior reservoir quality with average porosity values of 25%, NTG between 0.67 and 0.78, and water saturation values below 0.25, indicating significant hydrocarbon saturation. Reservoir O, though deeper and more compacted, also displayed favorable characteristics with porosity averaging 23% and NTG up to 0.96, confirming its economic viability.

CONCLUSION

Based on the integrated results and interpretations, the following conclusions are drawn:

1. ***Reservoir Characterization:*** Two hydrocarbon-bearing reservoirs (Reservoir N and Reservoir O) were identified within the Agbada Formation. Both exhibit good sand development, high NTG ratios, and moderate porosity, consistent with the properties of productive deltaic sandstones in the Niger Delta.
2. ***Structural Framework:*** The field is structurally dominated by listric normal growth faults and rollover anticlines, which define the major hydrocarbon traps. The faults act as both migration conduits and sealing boundaries, resulting in compartmentalized yet well-preserved reservoirs.
3. ***Regional Significance:*** The findings are consistent with the established structural and depositional models of the Niger Delta (Evamy et al., 1978; Doust & Omatsola, 1990; Reijers, 2011), confirming that the X - Field's reservoirs formed within the paralic to shallow-marine depositional regime of the Agbada Formation.

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