



Seismic and Petrophysical Analysis of Tomboy Field: Identifying Hydrocarbon Reserves in Niger Delta

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ABSTRACT

The Tomboy Field in the Niger Delta Basin is thoroughly examined in this article, with an emphasis on petrophysical research and seismic interpretation to pinpoint hydrocarbon reserves. To assess the field's reservoir potential, the analysis combines well log data, 3D seismic scans, and petrophysical characteristics like porosity, water saturation, and Net-To-Gross (NTG).

Six distinct reservoirs were delineated, each displaying varying hydrocarbon saturation levels, with Reservoirs 5 and 6 showing significant oil accumulations. The study highlights how crucial contemporary 3D seismic interpretation methods are for minimizing reservoir characterization uncertainty and maximizing field development.

Additionally, the application of Petrel software for stratigraphic and structural mapping allowed for the identification of potential drilling locations, with synthetic seismograms used to correlate well logs to seismic data. The results suggest the Tomboy Field contains untapped hydrocarbon potential, particularly in Reservoirs 5 and 6, which are recommended for further exploration and development. The results provide useful insights into optimizing hydrocarbon recovery through integrated seismic and petrophysical analysis and further our understanding of the geology of the Niger Delta Basin.

Keywords: seismic interpretation, well logs, petrophysical analysis, hydrocarbon reserves, Tomboy field,

1.0 INTRODUCTION

Using a suite of provided data, including integrated well logs and seismic data within a specified timetable, a subsurface study of Tomboy Field, which is situated in the southwest of the Niger Delta sedimentary basin in Nigeria, was conducted.

The main purpose of the project is to develop location(s) for drilling and development opportunities. The research work requires evaluating Tomboy field and discover opportunities that favour geology and economics that will make it profitable. It entails the practical application of my knowledge of basin **analysis, well logs interpretation, reservoir modelling, seismic interpretation (structure and stratigraphy) and petrophysics** and integrating all data set.

An attempt to know how viable a reserve is would require good understanding of the characteristics of the reservoir in the subsurface. Hence, there is need for the integration of methods like 3D seismic interpretation and petrophysical analysis. Modern 3D seismic interpretation and well logs involve the use of interactive software package e.g. Petrel.

The entire spectrum of issues, from exploration to development and exploitation, are addressed by 3D seismic surveys. They offer data for thorough reservoir characterization in an effort to lower reservoir uncertainty. Some rock attributes must be extracted

from well logs in order to achieve a particular level of assurance.

Petrophysical analysis provides information near the natural situation since the measurements are taken in-situ. Therefore, the use of well log data in the estimation of physical properties of rocks provide detailed information about the formation or beds penetrated by the given well. Petrophysical parameters estimated include porosity, saturation, fluid content e.t.c.

Rock physics may be used to forecast reservoir properties like lithologies and pore fluids, as shown by the quantitative interpretation of seismic and well log data. Oil and gas operators' strategies for exploration, production, and recovery have benefited recently from the use of these techniques in the Niger Delta.

In recent times, the application of these methods in the Niger Delta has aided exploration, production, and recovery plans of oil and gas operators.

1.1 Research Objectives

- i. Evaluation/assessment of resources within multiple reservoirs in Tomboy field.
- ii. Identify opportunities for future field development, if economic indicators are positive and favorable.
- iii. Fully optimise the reservoir so as to increase assets and investments.

1.2 Research Drivers

Following the discovery of the Oloibiri oil field in 1956, Nigeria began producing oil in 1958. With a reserve base of over 70 billion barrels of oil, Nigeria is now rated sixth in OPEC and fourteenth globally in the league of oil producers. The Tertiary Niger Delta Basin, where over 1,300 exploratory wells have been drilled, provides all of Nigeria's production potential.

The deepwater concessions are held under various production sharing contract agreements, whereas the majority of the onshore and shallow offshore concessions are held by multinational corporations under a Joint Venture (JV) agreement with a memorandum of understanding that guaranteed a profit to the operator depending on the price of oil.

Over time, exploration in the Niger Delta has decreased, mostly because to challenges in onshore

operations brought on by community-related disruptions, like as militancy, high bank interest rates, and industry reluctance to invest because of what are regarded to be unfavourable operating circumstances.

These have comparatively impacted Nigeria's production rate. Other operational elements to improve exploration activities include the government's stated goals of increasing local content and building local E&P capabilities in operatorship areas, encouraging new entrants to the exploration scene, expropriating JV licence holders' inactive assets, and forming partnerships and co-ventures by awarding marginal fields or blocks to indigenous operators.

As to these reasons, the Tomboy field was assessed to determine locations for drilling development so as to add to the declined oil and gas production.

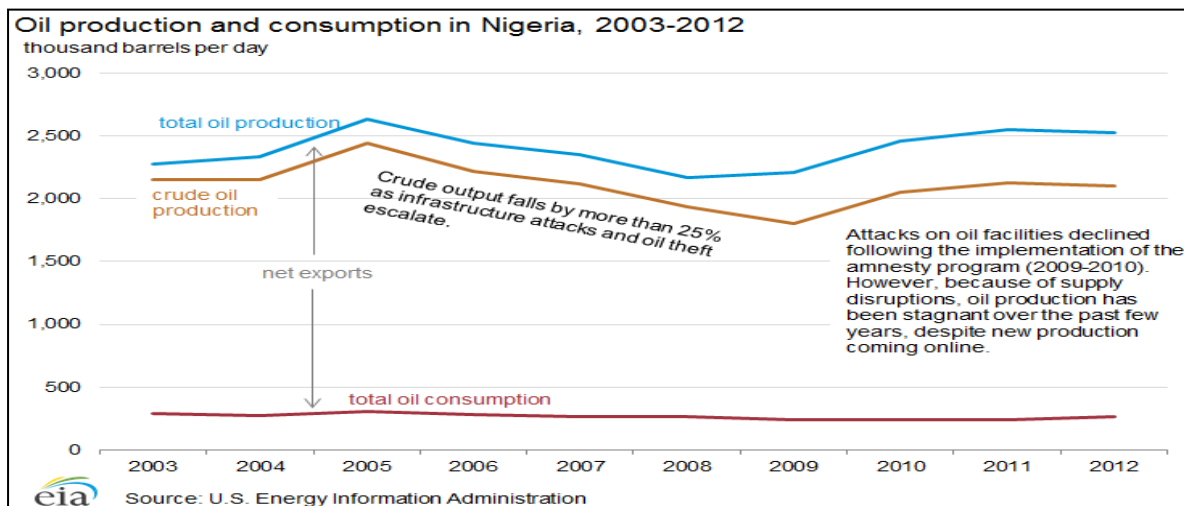


Figure 1: Oil Production and Consumption in Nigeria, 2003 – 2012.

1.3 Geologic Setting

The Niger Delta is a vast sedimentary basin located in southern Nigeria, bordering the Gulf of Guinea. It is recognized globally as one of the most prolific hydrocarbon-producing regions. The basin's geologic evolution is intricately linked to the tectonic processes associated with the opening of the South Atlantic Ocean during the Late Jurassic to Cretaceous periods. Its development is marked by the interaction of tectonic subsidence, sediment supply, and eustatic sea-level changes, which together produced the complex structural and stratigraphic framework observed today. Structurally, the Niger Delta comprises three principal zones that developed as a result of gravity-induced tectonics: the extensional zone on the continental shelf, the transitional zone characterized by rollover structures and growth faults, and the compressional zone in the deep offshore area, which contains thrust faults and imbricate fold belts. Recent interpretations of 3D seismic data have revealed further complexity in these structural provinces. According to Ogunleye et al. (2021), these structures evolved due to sediment

loading on ductile, overpressured shale sequences, notably within the Akata Formation, triggering large-scale detachment fault systems. The stratigraphy of the Niger Delta is traditionally divided into three major lithostratigraphic units: the Akata, Agbada, and Benin Formations. The Akata Formation, deposited from the Paleocene to the present, consists predominantly of marine shales and functions as the primary source rock in the petroleum system. Above it lies the Agbada Formation, ranging from Eocene to Recent, which comprises alternating sequences of sandstone and shale deposited in deltaic to shallow marine environments. This formation serves as the main reservoir rock in the basin. Overlying the Agbada Formation is the Benin Formation, an Oligocene to Recent sequence of continental fluvial sands that caps the delta system. Recent sedimentological investigations by Ehirim and Uko (2020) have provided refined depositional models for the Agbada Formation, demonstrating the influence of high-frequency sea-level changes and fluvial-deltaic dynamics in shaping its architecture. In terms of sedimentology, the Niger Delta is characterized as a

mixed wave-, tide-, and fluvially influenced system. Sediment supply is dominantly sourced from the River Niger and its tributaries, with annual sediment discharge exceeding 100 million tons. Detailed sedimentological and stratigraphic studies have shown that facies distribution within the delta is highly variable laterally and vertically, reflecting the interplay of coastal processes and relative sea-level fluctuations. Particularly in the offshore sector, turbidite systems have become increasingly important for exploration activities, as reported by Adebajo et al. (2022), who documented the development of deepwater fan complexes and their hydrocarbon potential. The petroleum system of the Niger Delta remains one of the most efficient globally, with the Akata Formation serving as the primary source rock composed largely of Type II and III kerogen. The Agbada Formation hosts high-quality reservoirs with average porosity ranging from 20% to 35%, and permeability values exceeding 1000 mD in some zones. These reservoirs are sealed by interbedded shales and the overlying Akata Formation. Recent geochemical and petrophysical studies have

also highlighted the potential of unconventional resources within the delta, including tight sand reservoirs and offshore gas hydrates (Ojeh et al., 2023). The emergence of these unconventional plays is driving new interest and investment in frontier areas, particularly in deeper offshore settings. Environmental and geohazard considerations have gained prominence in recent years. The delta is highly susceptible to subsidence, coastal erosion, and flooding—risks that have been exacerbated by hydrocarbon extraction and sediment compaction. Nwankwo and Ofoegbu (2019) have documented significant land subsidence in various parts of the eastern and central delta, raising concerns about infrastructure stability and community displacement. In offshore regions, the risk of slope instability and potential submarine landslides has also been documented. Chukwu et al. (2024) warn that increased sediment loading and gas venting in these deepwater environments may pose operational and environmental hazards, necessitating more detailed geotechnical assessments in exploration and production planning.

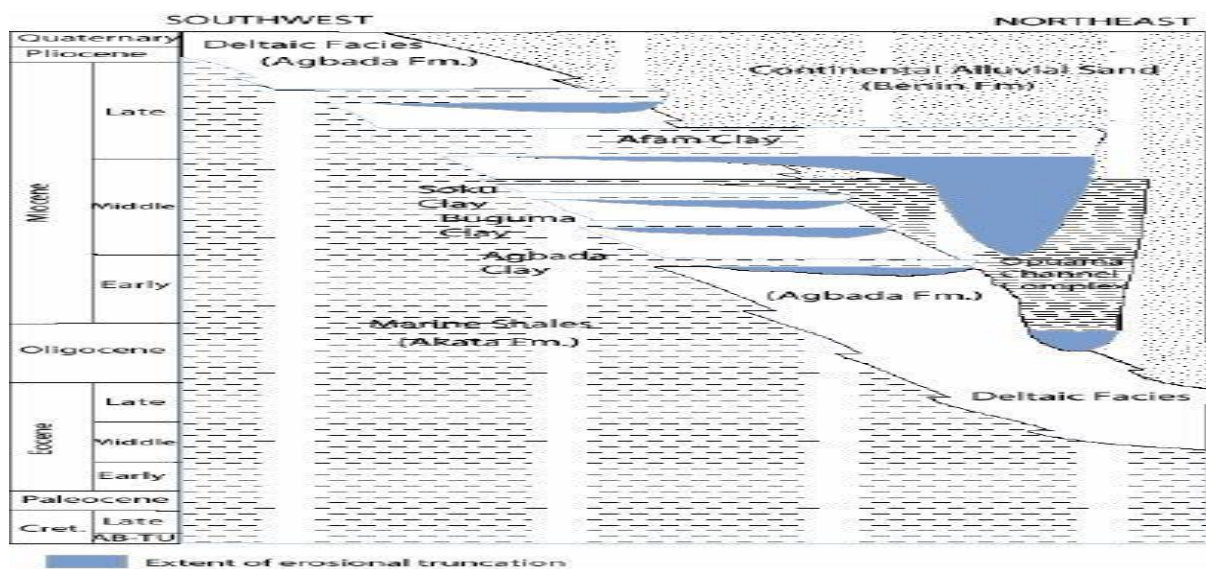


Figure 2. The Three Niger Delta Formations Are Depicted In This Stratigraphic Column (Adapted From Doust And Omatsola; After Tuttle et al.).

1.5 Structural Geology

The structural geology of the Niger Delta is defined by complex interactions between sedimentary loading, gravitational tectonics, and the tectonic evolution of the South Atlantic passive margin. This dynamic system has produced a variety of structural styles, which not only influence the geologic development of the basin but also play a critical role in hydrocarbon generation, migration, and entrapment.

The Niger Delta developed during the Late Cretaceous to Recent in response to the rifting and subsequent drifting of the African and South American plates. The delta lies within a divergent passive margin setting,

where subsidence was initially driven by lithospheric thinning and later by sediment loading and compaction. The region is typically subdivided into three structural provinces that reflect the main tectono-stratigraphic framework: the extensional, transitional, and compressional zones.

In the **extensional province**, which lies beneath the continental shelf, sediment accumulation on the underlying ductile Akata shale formation initiated gravity-driven extension. This resulted in the development of listric normal faults, rollover anticlines, and crestal collapse structures. These features are prominent in seismic data and are often associated with

hydrocarbon traps. According to Ogunleye et al. (2021), extensional deformation was triggered by differential loading and lateral movement of the overpressured shales of the Akata Formation, producing a complex network of growth faults with characteristic rollover structures in the overlying Agbada Formation.

Moving basinward into the **transitional zone**, the tectonic regime shifts to a more balanced state, where both extensional and compressional features may co-exist. This zone is typified by growth fault systems with associated toe thrusts and counter-regional faults. Structural styles here are heavily influenced by the thickness of the Agbada Formation and the degree of overpressure within the Akata Formation. The faults in this zone often act as both migration pathways and traps, making them critically important in petroleum exploration. High-resolution seismic studies (Adebanjo et al., 2022) have shown that rollover anticlines and shale diapirs are common in this region, often serving as structural closures for hydrocarbon accumulation.

In the **compressional province**, which lies in the deep offshore area, the structural style becomes increasingly complex. Here, sediments have prograded seaward over a mobile shale base, resulting in compressional deformation manifested as imbricate thrusts, detached folds, and mud diapirism. This area, previously considered frontier terrain, has attracted increasing exploration interest due to large hydrocarbon discoveries in deepwater turbidite systems. Chukwu et al. (2024) documented the presence of thrust-fault-related folds and seafloor instabilities, indicating active sediment movement and structural reactivation in this compressional regime.

Throughout the Niger Delta, **shale mobility and overpressure** within the Akata Formation have had a significant impact on structural evolution. The ductile nature of these shales has facilitated large-scale detachment faulting, listric fault geometries, and mud diapirism. These features are not only diagnostic of the delta's structural character but also critical in controlling hydrocarbon migration and entrapment. Modern studies involving 3D seismic interpretation and geomechanical modeling have highlighted the temporal evolution of these structures, demonstrating that many faults remain active and may contribute to geohazards such as subsidence and slope failure (Ojeh et al., 2023; Chukwu et al., 2024).

Another important aspect of the structural geology is the occurrence of **shale diapirs and mud volcanoes**, which are commonly found in both onshore and offshore settings. These structures result from differential compaction and fluid overpressure, and they often pierce through the overlying Agbada and

Benin Formations. Their presence influences sedimentation patterns and may form traps or barriers to hydrocarbon migration. Ehirim and Uko (2020) emphasized that the interaction between diapiric movement and sediment deposition has resulted in local stratigraphic complexity that must be carefully evaluated during reservoir characterization.

Recent studies also point to the influence of **regional tectonic reactivation** on fault systems within the Niger Delta. Although the delta lies within a passive margin setting, there is evidence for minor tectonic rejuvenation linked to intraplate stresses and deep-seated lithospheric movements. Nwankwo and Ofoegbu (2019) noted that fault reactivation may play a role in induced seismicity and could impact reservoir integrity, especially in mature fields where reservoir pressure is actively managed through enhanced recovery methods.

The structural framework of the Niger Delta is primarily governed by gravity-driven tectonics, which result from high sedimentation rates over the ductile, over-pressured Akata Shale. This mechanism produces key structural elements such as listric normal faults, rollover anticlines, shale diapirs, and compressional toe-thrusts, forming essential hydrocarbon traps in the region (Adeyemi et al., 2019; TGS, 2023).

The delta is sub-divided into five main depobelts—Northern Delta, Greater Ughelli, Central Swamp, Coastal Swamp, and Offshore—each characterized by distinct deformation intensities and growth fault systems (Ezekwe et al., 2021). Listric growth faults, often extending several kilometers, are the most significant structural features, forming large rollover anticlines, which dominate the Niger Delta's hydrocarbon reservoirs (Oluwafemi et al., 2022). Recent high-resolution 3D seismic interpretations, such as those from the MegaSurveyPlus project, have improved understanding of deeper and more complex structures, including strike-slip tear faults, toe-thrusts, and en-échélon fault systems, especially in the deep offshore regions (TGS, 2023; Onyekachi & Ayeni, 2022). These structures affect sediment distribution, trap integrity, and hydrocarbon migration paths. Shale diapirism, resulting from the mobilization of over-pressured shales, plays a major role in reservoir compartmentalization and trap formation. Diapirs often pierce through overlying strata and impact sedimentary architecture (Ukaegbu et al., 2020). Moreover, the structural-stratigraphic interplay between active faulting and syn-depositional processes defines channel migration, sediment trapping, and reservoir heterogeneity across the delta (Chukwudi & Zhang, 2023).

In summary, the structural geology of the Niger Delta is primarily governed by gravitational tectonics driven by high sedimentation rates over mobile shales. The resulting structural features—including listric normal faults, rollover anticlines, shale diapirs, and compressional folds—form the backbone of the delta's petroleum system.

Five major depobelts are generally recognized namely:

- i. Northern Delta
- ii. Greater Ughelli,
- iii. Central Swamp
- iv. Coastal Swamp
- v. Offshore

Large syn-sedimentary growth faults, rollover anticlines, and shale diapirs that deformed the delta complex are the Niger Delta's most notable structural characteristics (Evamy et al., 1978). Rollover anticlines are linked to a higher proportion of the Niger Delta's on-fields.

1.6 Petroleum System

The Niger Delta Basin hosts one of the most prolific petroleum systems in the world, contributing significantly to global hydrocarbon supply since the mid-20th century. The petroleum system of the Niger Delta is a classic example of a Tertiary deltaic basin in a passive continental margin setting. Its effectiveness stems from the optimal combination of rich source rocks, excellent reservoirs, effective seals, and abundant traps.

At the heart of the Niger Delta Petroleum System is the **Akata Formation**, which functions as the primary source rock. This formation consists predominantly of marine shales deposited in deep, low-energy anoxic environments from the Paleocene to Recent. It contains Type II and Type III kerogen, capable of generating both oil and gas. Maturity profiles derived from recent basin modeling efforts (Ojeh et al., 2023) confirm that large parts of the Akata Formation, especially in the deep offshore, are within the oil and gas windows, with thermal maturity increasing basinward due to higher burial depths and geothermal gradients.

Overlaying the Akata Formation is the **Agbada Formation**, which serves as the principal reservoir unit. This Eocene to Recent unit comprises alternating sequences of sandstone and shale deposited in a variety of deltaic and shallow marine settings. The sandstones within the Agbada Formation exhibit excellent porosity (20–35%) and permeability (>1000 mD in some zones), making them highly efficient hydrocarbon reservoirs. Detailed sedimentological analyses by Ehirim and Uko (2020) show that these sand bodies are laterally discontinuous and influenced by frequent channel migrations and avulsion processes, which necessitate high-resolution reservoir modeling for accurate field development.

The **Benin Formation**, the youngest unit in the delta's stratigraphy, consists of continental fluvial sands and acts primarily as a regional aquifer. However, it also plays a minor role in sealing or confining hydrocarbons in shallower accumulations. The **primary seal** for the system is provided by the thick, interbedded shales of the Agbada Formation, while the deeper Akata shales can act as both source and seal, especially in structural closures. These seals are generally effective at preventing vertical hydrocarbon migration, although recent studies by Ogunleye et al. (2021) suggest that overpressure and fault reactivation can sometimes compromise seal integrity, particularly in areas of intense subsurface deformation.

The **trap styles** within the Niger Delta are varied and abundant. The most common are **structural traps**, associated with growth faulting and rollover anticlines. These are often accompanied by fault-bounded traps and horst/graben structures in extensional settings. **Stratigraphic traps**, although less common, occur due to lateral facies changes and pinch-outs within the deltaic sequences. Additionally, **combined structural-stratigraphic traps** have gained prominence in deepwater settings, where turbidite sands are bounded by shale drapes and mudstone interbeds. Adebajo et al. (2022) documented such traps in deep offshore blocks, where hydrocarbons are sequestered in basin floor fans and channel-levee complexes.

Hydrocarbon migration is predominantly vertical from the Akata source rocks into the Agbada reservoirs, facilitated by fault conduits. Lateral migration also occurs within high-permeability sandstone beds, particularly in areas where regional dips support such movement. Migration pathways are closely associated with active fault systems and diapiric structures, as highlighted by Chukwu et al. (2024), who identified several migration fairways using integrated 3D seismic and fluid inclusion data. The presence of shale diapirs and mud volcanoes further supports the existence of overpressured compartments and episodic fluid release events, which have important implications for both exploration risk and environmental safety.

The **hydrocarbon types** in the Niger Delta range from light oils to condensates and dry gas, with oil being dominant in the onshore and shallow offshore areas, while gas and condensate fields are more common in the deep offshore. Gas discoveries have increased significantly in recent years, positioning Nigeria as a major player in the global LNG market. In addition to conventional resources, **unconventional petroleum systems** are being evaluated. These include tight gas reservoirs, shale gas prospects, and deepwater gas hydrates. According to Ojeh et al. (2023), geochemical screening and maturity modeling suggest that parts of

the deep offshore basin could support viable unconventional gas plays, although significant technological and infrastructural challenges remain. Overall, the petroleum system of the Niger Delta is a well-established yet evolving system. While much of the onshore and shallow marine potential has been extensively developed, deepwater and unconventional resources are now at the frontier of exploration. The key elements—source rock, reservoir, seal, and trap—remain robust across most of the basin. However, modern challenges including reservoir compartmentalization, seal integrity, and environmental risks such as subsidence and slope failure must be addressed using integrated geological and engineering approaches. With continued advancements in seismic imaging, basin modeling, and petrophysical analysis, the Niger Delta is poised to remain a vital energy hub well into the future.

1.6.1 Source rock

The **Akata Formation** is the primary source rock of the Niger Delta petroleum system. It is a thick sequence of marine shales, often overpressured and ductile, deposited in prodelta to deep marine settings from the Paleocene to Recent. This formation is rich in organic matter, predominantly Type II (oil-prone) and Type III (gas-prone) kerogen, making it capable of generating both oil and gas depending on its maturity.

Geochemical analyses from recent work by **Ojeh et al. (2023)** confirm the Akata shale's total organic carbon (TOC) content typically ranges between 1.5% and 8.0%, with hydrogen indices (HI) indicative of strong oil-generating potential in shallower zones and gas generation potential at deeper burial. Thermal maturity increases basinward and with depth, placing much of the offshore Akata sequence within the oil and gas windows. The shales also exhibit high hydrocarbon generation efficiency, as shown by recent pyrolysis and biomarker studies, further solidifying their role as the source kitchen for most hydrocarbons in the basin.

1.6.2 Reservoir rock

The **Agbada Formation**, which overlies the Akata Formation, provides the main reservoir facies in the Niger Delta. Deposited from the Eocene to the Present in deltaic, distributary, and shallow marine environments, the Agbada Formation comprises alternating layers of sandstones and shales. These sandstones, often fluvio-deltaic in origin, are laterally and vertically heterogeneous but generally possess excellent reservoir qualities. Porosity values typically range between **20% and 35%**, with permeability often exceeding **1,000 millidarcies (mD)** in unconsolidated, cleaner sand units (Ehirim & Uko, 2020). The reservoir intervals are often found in channel-fill, distributary mouth bar, and shoreface depositional environments. High-resolution core and seismic interpretations

indicate that sedimentary structures such as cross-bedding, bioturbation, and grain sorting are common, all contributing to favorable flow characteristics. In recent years, **deepwater turbidite sands** in the Agbada-equivalent strata have emerged as significant exploration targets. These reservoirs are typically found in submarine fan systems, where thick, laterally extensive sands are interbedded with shales, forming stratigraphic and combined traps. These newer plays are particularly attractive due to their large areal extent and good continuity.

1.6.3 Trapping styles

The **trapping mechanisms** in the Niger Delta are varied and have evolved with the structural development of the basin. The dominant traps are **structural**, often associated with **growth faults**, **rollover anticlines**, and **fault-bounded closures**. These traps developed in response to the delta's rapid sediment loading over the ductile Akata shales, which induced gravity-driven extensional faulting, especially in the shallow offshore.

In many onshore and shelfal areas, hydrocarbons are trapped in anticlinal structures bounded by listric growth faults that sole out into the overpressured Akata Formation. These faults act as both migration pathways and trapping mechanisms. **Crestal fault closures**, **horst and graben systems**, and **relay ramps** are also common structural traps identified in 3D seismic surveys (Ogunleye et al., 2021).

Stratigraphic traps are less common but significant, particularly in the deep offshore. These include **pinch-outs**, **facies terminations**, and **channel-lobe complexes** in turbidite settings. **Combined structural-stratigraphic traps** are increasingly targeted, especially where turbidite channels are bounded by shales or where faulting creates lateral seals.

The **seal rocks** are primarily provided by the intraformational shales within the Agbada Formation, as well as by the Akata shales below. These shales are laterally extensive and exhibit low permeability, effectively sealing hydrocarbons within the porous sandstone reservoirs. Recent studies by **Chukwu et al. (2024)** emphasize the importance of these seals, particularly in deepwater settings where slope instability and shale mobility can occasionally breach structural traps.

1.7 Study area (Tomboy Field) within the Niger Delta

The research location, Tomboy Field, is a concession owned by Chevron Texaco Limited and is situated near the western edge of the offshore Niger Delta (Fig 3). The research region's coordinates are located in the South-South Nigeria geopolitical zone (Offshore

Niger-Delta), which spans an area of 55 km² and lies between Northings 66300 and 71800m and Eastings 477500 and 487500m (Fig 4). With a 25-meter gap between lines, the In-lines and Cross-lines fall into the 5800–6200 and 1480–1700 ranges, respectively. TMB01, TMB02, TMB03, TMB04, TMB05, and TMB06 were the six (6) wells that were drilled. Out of the six wells, wells TMB04 and TMB05 have comprehensive well logs that include resistivity, gamma ray, checkshot, sonic, neutron/density, and calliper logs (Table 1).

Only in wells TMB04 and TMB05 can a synthetic be developed using the density and sonic logs available, and it may then be extrapolated to other wells. While the well log data is in LAS format, the 3-Dimensional seismic volume is in SEG-Y format. There was no geochemical analysis or data provided for this project that matched the biostratigraphic data. The nature of the source rock, reservoir, and seal is inferred from earlier research conducted in the Niger Delta basin, which is home to this field.

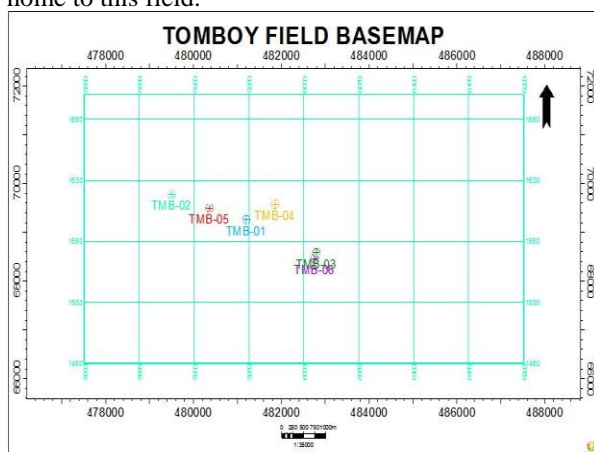


Figure 3. Tomboy Field Base Map

2.0 MATERIALS AND METHODS

2.1 Material

Based on the available data given for this project as mentioned above, it is imperative to develop a workflow as to achieve reasonable results within the time frame allocated. All the data were loaded on Windows Operating System and run on Schlumberger Petrel 2009 software. Schlumberger Petrel Software is a 3D visualization tool used for seismic interpretation, stratigraphic correlation, modelling etc. The well log data was loaded on the Windows Operating Software to check for the quality of data given before commencing work. Also, the seismic data set (SEG-Y) header was scrutinised using a seg-y viewer to check for anomalies in the data set provided. After careful quality control (QC) and quality assurance (QA), detailed work was carried out on the project.

2.2 Method

The Schlumberger Petrel 2009 software was lunched to define the project datum by setting the appropriate units and coordinates for the project. The used units and coordinates for this project is “Nigeria Mid Belt – Minna” and other required parameters were set to appropriate units. First, the well logs and 3D seismic data were worked on simultaneously. Logs that corresponded to each well were loaded. The stratigraphic sequence stacking pattern was interpreted using gamma ray log response or theme. To distinguish the shale from the sand packages, a relative 65-75 shale base line was employed. The amount of hydrocarbons in the sand packages was ascertained using the resistivity log response. The various fluid types in each of the sand packages listed above were identified using neutron and density logs that were available for a small number of the wells. The resistivity log was used to identify six reservoir sands (Fig 4).

Tomboy Reservoir Correlations

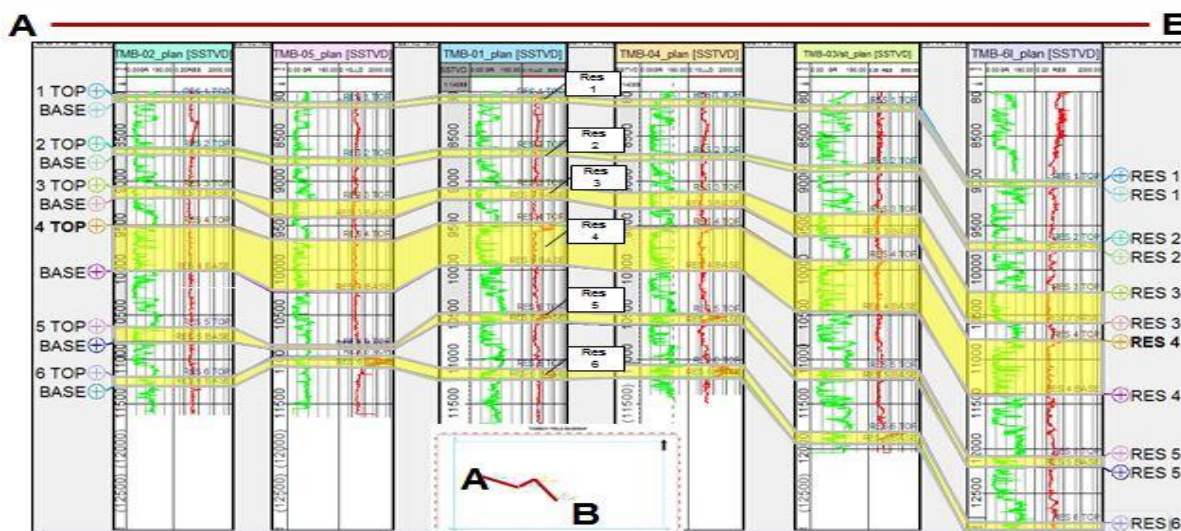


Figure 4. 6 Reservoirs Correlated Across The Wells

The 3D seismic data was loaded and the quality of the data was checked for easy structural and stratigraphic interpretations. Spanning across the 3D volume, the upper part around 1350ms, shows chaotic reflections that has moderate to bright amplitude continuous reflections. At the middle of the seismic section around 1900ms – 2800ms, there is bright amplitude continuous reflections which can be used to infer lateral continuity across the seismic volume. 2700ms and below, the seismic display is bright amplitude discontinuous reflection. (Fig 6). After checking the seismic volume, structural interpretation was done. Faults were selected at ten inline interval parts beginning with Inline 5800, and they were then reflected on the cross-lines sections. In order to create a temporal and depth structure map of the horizons using a synthetic well tie, the reservoir sands were subsequently correlated in the 3-D seismic volume. Following correlation, the Schlumberger Petrel software's 2D map window generated time and depth structure maps. Plotting the appropriate velocity model allowed for the determination of the time depth connection.

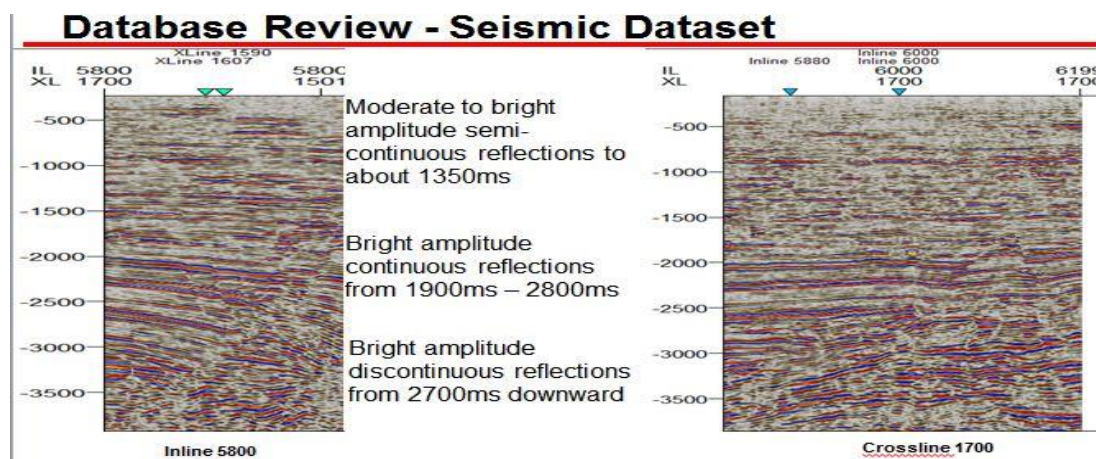


Figure 5. Seismic Data Review.

3.0 RESULTS AND DISCUSSIONS

Five (5) Maximum Flooding Surfaces (MFS), five (5) Flooding Surfaces, and five (5) Sequence Boundaries were delineated from TMB-01, which served as the composite type log to correlate with other wells throughout the field, based on the well logs that were supplied.

The line of section for the correlation was chosen based on the close proximity of one well to the other. Six (6) reservoirs with pay (hydrocarbon) were observed and equally correlated across the wells. Reservoir 4, 5, 6 has more hydrocarbons fill than the others

NW-SE Stratigraphic Well Correlation

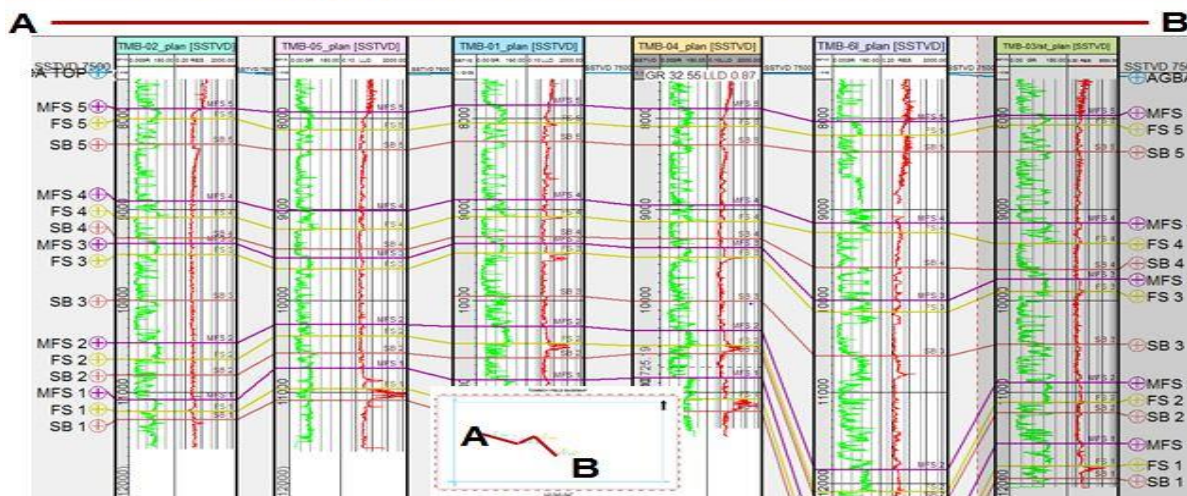


Figure 6. Stratigraphic Correlation Across 6 Wells.

Seismic Well-tie

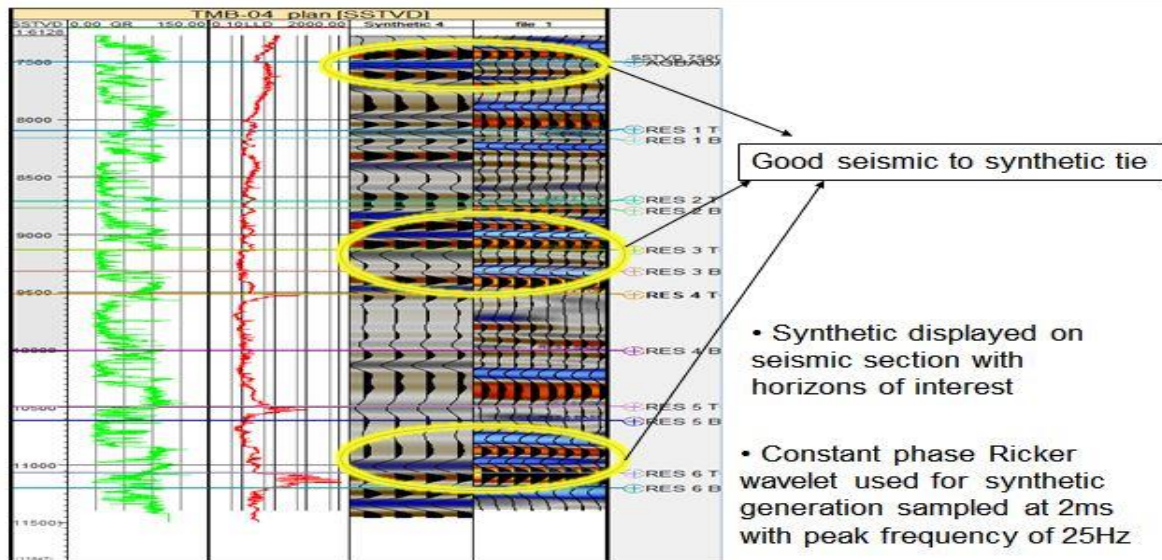


Figure 7. Seismic To Well Tie Correlation In TMB-04

4.0 DISSCUSSIONS

According to the seismic Inline 6000, the wells in the Tomboy field trend from TMB-02 to TMB-06 in a NE-SW direction. Although there are chaotic reflections at the lowest portion of the seismic volume, the 3D seismic data volume is useful for structural and stratigraphic interpretation. Here, faults were selected based on the observed discontinuous reflection at 10-inline intervals. Sixteen faults in all were selected from the seismic section. A few antithetic flaws and two big building defects (synthetic faults) are present. These are faults 1 and 6, with fault 3 providing structural balance. As the seismic inlines were interpreted, additional small faults emerged. The different time slice variances showed these flaws.

The well (reservoirs) had to be marched to seismic during the project's duration. To do this, the acoustic and density logs from TMB-04 and TMB-05 were used to create synthetic seismograms. In order to establish a character relationship between the well and the seismic along the well trajectory, the synthetic was completed. For synthetic generation, a constant phase Ricker wavelet was employed, recorded at 2 ms with a peak frequency of 25 Hz (Fig 9). The reservoirs' picks were sketched out across the inlines at 10-inline intervals after a strong tie was established. To observe their actions, this was flexed on the crossline. For the purpose of creating time structural maps for the six reservoirs, six horizons were created.

The Time/depth connection created from the checkshot data in Tomboy 4 to convert to depth (TVDSS) was utilised to convert the time structural maps to depth structural maps utilising a polynomial function. There is a strong link between the depth maps and the time maps.

4.1 Formation evaluation and petrophysics

Tomboy field petrophysical assessment was done by evaluating the key parameters for the calculation of STOIP. In doing this, the net to gross (NTG), reservoir thickness (h), area (a), porosity (Φ), water saturation (S_w), Conversion factor (cf) and the formation volume factor (FVF) must be known. Most of the parameters used were calculated from the Schlumberger Petrel 2009 software while others are known values from Niger Delta fields.

The conversion factor and formation volume factor of the fluid type in Niger delta and the pressure gradient is assumed to be;

$$Bo: 1.35(\text{Elam}, 1957) \quad (1)$$

$$Cf: 7758 \quad (2)$$

Where

$$STOIP = (GRV * S_o * NTG * CF * \phi) / FVF \quad (3)$$

4.2 Porosity Determination

Porosity was determined through Density-Log from four of the wells but was averaged and extrapolated to other wells. The standard formula for calculating porosity is given below as

$$\Phi = \frac{(\rho_{ma} - \rho_b)}{(\rho_{ma} - \rho_f)}$$

Where;

ρ_{ma} : Density of matrix of 2.65g/cc

ρ_b : Bulk density

ρ_f : Density of fluid of 1g/cc
1g/cc because its water.



Table 1. Average Porosity Values

RESERVOIRS	TMB 05	TMB 06	AVE POROSITY
RES1	0.203333	0.253333	0.23
RES2	0.216667	0.256667	0.24
RES3	0.216667	0.273333	0.25
RES4	0.216667	0.273333	0.25
RES5	0.2	0.176667	0.19
RES6	0.2	0.226667	0.21

5.0 CONCLUSION

Within the Tomboy field (study area), two major structure-building faults were delineated running from west to east and serving as barrier/baffles for the closures i.e., fault dependent closure and fault independent closures. Five Maximum Flooding Surfaces (MFS) and Five Sequence Boundaries (SB) were drawn from the gamma logs and carried throughout Tomboy Field in each well. To connect the wells to seismic and track the reservoir top across the field, a synthetic seismogram was created. A comparable time map was created using six selected horizons. Six depth maps were created by convolving the time maps with a polynomial function. The primary structural trap consists of horsts, tilted fault blocks, rollover folds, and fault closure. All of the field's wells were associated with six reservoirs, and corresponding structural (depth and time) maps were produced.

Petrophysical Analysis from the log was computed against the areas of reservoirs 5 and 6, their corresponding STOIP and Recoverable values of 5.1/1.5MBO and 30.2/9.1MBO were calculated respectively.

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