Open Journal of Applied Sciences, 2024, 14, 2923-2942
https://www.scirp.org/journal/ojapps
ISSN Online: 2165-3925
ISSN Print: 2165-3917

# Geological Interpretation and Identification of Albian-Aged Petroleum Prospects in Block A, San Pedro Margin (Côte d'Ivoire)

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**How to cite this paper:** Ahoure, N.D., Egoran, B.A., Kouadio, G.R.N., Mobio, C.M., Digbehi, Z.B. and Allialy, M.E. (2024) Geological Interpretation and Identification of Albian-Aged Petroleum Prospects in Block A, San Pedro Margin (Côte d'Ivoire). *Open Journal of Applied Sciences*, **14**, 2923-2942.
https://doi.org/10.4236/ojapps.2024.1410191

**Received:** September 17, 2024
**Accepted:** October 25, 2024
**Published:** October 28, 2024

## Abstract

The study aims to identify Albian-age oil prospects in Block A of the San Pedro margin, Côte d'Ivoire, by conducting a detailed geological interpretation. The objective is to confirm the presence of oil reservoirs trapped by favorable geological structures, identifiable through geophysical and seismic methods. The methodological approach is based on a combined analysis of studies and seismic data. Drilling data from well PA, including well logs and end-of-well reports, were used to characterize the lithological formations encountered, particularly those of the Albian. 3D seismic profiles were interpreted to identify structures conducive to hydrocarbon accumulation. Isochrone, isovelocity, and isobath maps were developed to refine the interpretation. Sedimentological analyses revealed five sandy/gritty levels between 2610 m and 3100 m, interspersed with clay, limestone, and siltstone beds. The seismic profiles highlighted two main prospects. These prospects exhibit favorable geological structures, including normal faults and structural traps that provide oil traps.

## Keywords

Sedimentology, 3D Seismic, Prospect, Albian, Côte D'Ivoire

## 1. Introduction

The San Pedro margin, located along the southwestern coast of Côte d'Ivoire, is an integral part of the sedimentary basin of the Gulf of Guinea, which was formed following the opening of the South Atlantic in the Lower Cretaceous [1]-[4]. This margin contains a rich sedimentary sequence, ranging from the Cretaceous to the Tertiary, with a particular focus on the Albian age due to its oil potential. The Albian-age formations, often associated with depositional environments favorable to hydrocarbon accumulation, thus represent a prime target for oil exploration in the region [5]. The primary objective of this study is to conduct a detailed geological interpretation of Block A on the San Pedro margin, highlighting the Albian-age oil prospects. The hypotheses of this research posit that the Albian-age formations contain high-quality oil reservoirs, trapped by favorable geological structures identifiable through geophysical and seismic methods [6] [7]. Previous studies on the San Pedro margin have revealed potential oil reservoirs in various stratigraphic sequences, but few have focused specifically on the Albian age. While the works of [6] [7] provide theoretical foundations on basin formation and trap structures in West Africa, the San Pedro margin remains under-studied compared to other regions of the Gulf of Guinea [8] [9].

## 2. Presentation of the Study Area

The study area is located along the San Pedro margin (**Figure 1**), specifically between latitude 04˚19'49''N and longitude 06˚48'67''W. It covers an area of 1059.25 km$^2$. A single vertical well, named PA, was drilled by the VANCO company, reaching a total depth of 3100 m down to the Albian. The last formation encountered belongs to the Albian, situated between 2610 m and 3100 m.

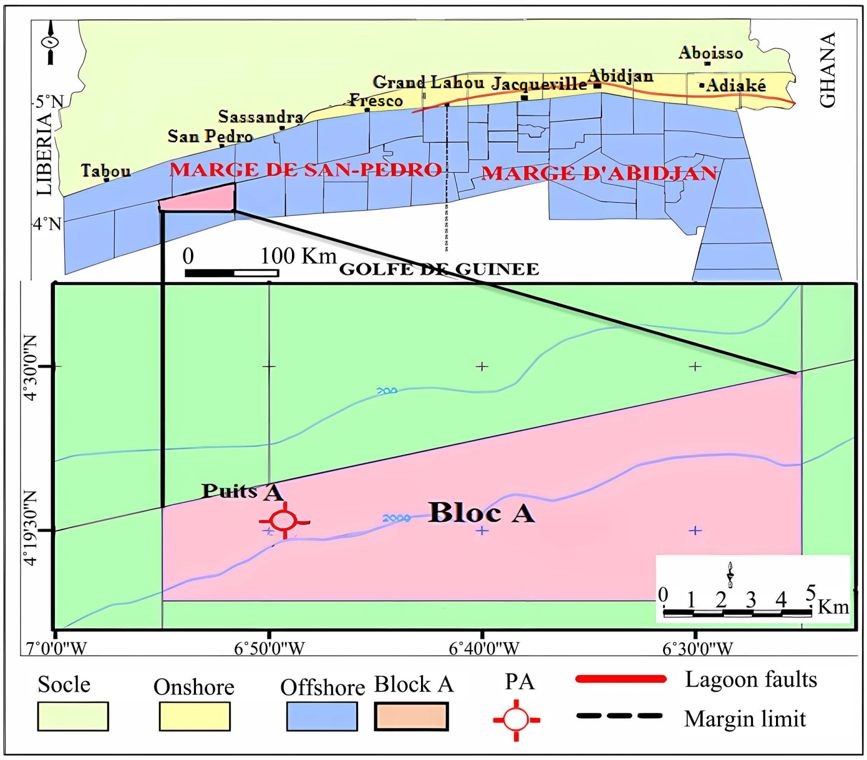


**Figure 1.** Overview of the study area.

# 3. Materials and Methods

## 3.1. Materials

### 3.1.1. Geological End-of-Well Reports

As part of this study, we used the end-of-well report from well PA. The various data collected in these reports (drilling data, analysis time, well logging, and lithological description) provided all the relevant information for optimal analysis and interpretation of the seismic profiles and logs.

### 3.1.2. Seismic Data

**Seismic Lines: Positioning Plan**

The seismic profiles were extracted from the 3D seismic survey conducted by WESTERN GECO in 2001 on behalf of the VANCO company (Figure 2). The acquisition covered an area of 1200 km$^2$. Eight (8) seismic lines in paper format served as the basis for this work. These seismic lines are presented in Table 1 and Table 2 and illustrated in the positioning plan.

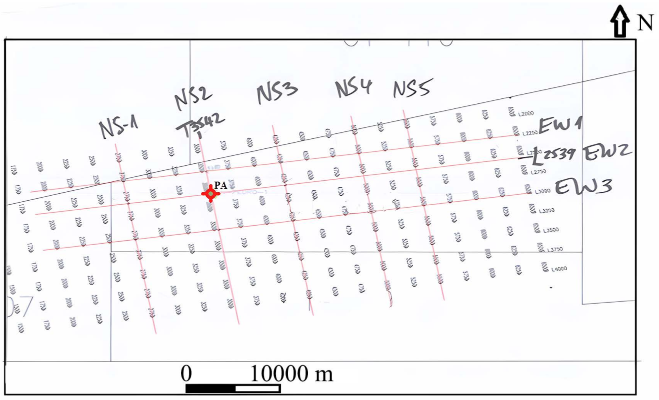


Figure 2. Example of a positioning plan for Block A.

Table 1. List of North-South lines.

| Year | Operator | Acquisition | Ligne names | Nature of the survey |
|---|---|---|---|---|
| 2005 | Vanco | Western Geco | NS-1<br>NS-2<br>NS-3<br>NS-4<br>NS-5 | 3D |

Table 2. List of East-West lines.

| Year | Operator | Acquisition | Ligne names | Nature of the survey |
|---|---|---|---|---|
| 2005 | Vanco | Western Geco | EW-1<br>EW-2<br>EW-3 | 3D |

- Five (5) North-South lines (Table 1);
- Three (3) East-West lines (Table 2).

* Well Data: Top + Checkshot.

This refers to the tops of geological formations and a Time-Depth Table used for converting time data to depths and vice versa.

## 3.2. Methods

### 3.2.1. Positioning of the Albian Top

The top of the Albian was identified based on a sharp change in the log signatures, indicating a change in facies or a discontinuity [10].

### 3.2.2. Sedimentology

- **Lithological Characterization**

The lithological study was carried out using data from the end-of-well geological reports and well logging. The determination of various levels was also based on the interpretation of the Gamma Ray log curve.

### 3.2.3. Seismic Method

The interpretation of the 3D seismic data in this study aims to identify all prospects in Block A and to validate those highlighted by the previous operator, VANCO.

- **Data Quality Control**

This step is crucial before any seismic interpretation. It involves a visual assessment of seismic reflectors, considering their continuity, clarity, and resolution. Understanding the processing sequences applied is also essential to grasp the evolution of seismic reflectors.

- **Well Tie**

Using the geological well report and checkshot data, we determined the depth corresponding to the top of the Albian for well PA. The obtained value was not directly listed in the checkshot table but fell between two values (see Table 3). Therefore, it was necessary to perform an interpolation of this value. For this, we used one of the linear interpolation formulas (Formula (1)).

Table 3. The checkshot log of well PA.

| Depth (m) | Md (m) | X (m) | Y (m) | Time (ms) | TVD Below Well Elev |
|---|---|---|---|---|---|
| 2574.9084 | 2600 | 4.093867 | −3.8006601 | 3277.2 | 2599.9084 |
| 2594.8018 | 2619.9 | 4.4881353 | −4.116755 | 3294.6 | 2619.8018 |

$$f(x) = y_a + (x - x_a)\frac{y_b - y_a}{x_b - x_a}; \tag{1}$$

$$f(x) = \frac{x_b - x}{x_b - x_a} y_a + \frac{x - x_a}{x_b - x_a} y_b;$$

$$f\left(x\right)=\frac{y_a-y_b}{x_a-x_b}x+\frac{x_a y_b-x_b y_a}{x_a-x_b}y_b;$$

We calculated the time to the top of the Albian by performing the following operation:

$$T_A=\frac{\left(Z_A-Z_1\right)\left(T_2-T_1\right)}{Z_2-Z_1}+T_1 \tag{2}$$

$T_A$: Time to the top of the Albian in the well considered, in seconds (s).

$Z_A$: Depth to the top of the Albian in the well considered, in meters (m).

$Z_1$ and $Z_2$: Depths surrounding the top of the Albian.

$T_1$ and $T_2$: Time intervals surrounding $T_A$.

Finally, the result obtained for the top of the Albian on the seismic profile is actually a projection of the calculated time onto that same seismic profile.

- **Horizon Picking (Albian)**

This involves identifying the marker recognized during the previous step across all available sections. In this study, the Albian horizon is an erosion surface, and the terminations of reflectors helped us recognize it. An erosion surface is characterized by seismic sequences such as onlap, downlap, toplap, and erosion truncations, which are easily identifiable on seismic sections (Figure 3).

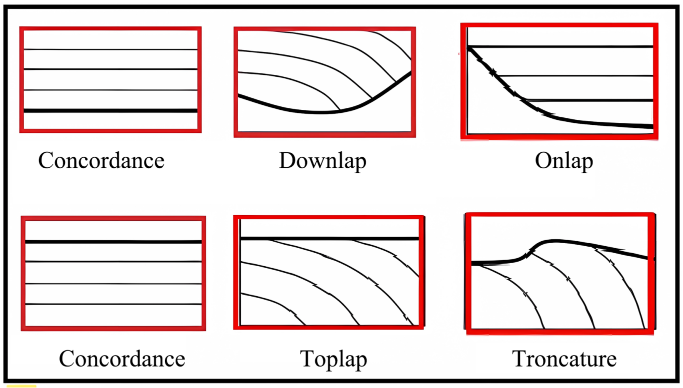


Figure 3. Diagram illustrating the different types of reflector configurations and terminations observable in seismic data [11].

Once the boundary of the sedimentary sequence is established at the well, we can now track and mark this boundary across all seismic profiles. The boundary is then plotted on a seismic section and compared to another section obtained from intersecting profiles to identify the same reflector on two crossing lines. This is known as the "Loop Tie" technique. In this work, the marking was done manually.

- **Timing of the Picked Horizon**

This step involves recording the two-way travel times (TWT) corresponding to each shotpoint. The recorded values are then transferred onto the positioning map of the survey to associate each shotpoint with a time value. These data will be used for creating the isochrone maps.

- **Creation of the Isochrone Map**

One of the main objectives of seismic interpretation is to create a contour map representing reflection times for each seismic horizon. Once the reflector is identified, reflection times are noted along the profiles and then transferred to the positioning map. Isochrones are then drawn to produce a structural time map. Before drawing the curves, it is crucial to mark all faults and determine how to connect them, ensuring they match the map at the picked horizon. The curves are then drawn between the faults. The isochrone map was created manually using the interpretive contouring method.

- **Creation of the Isovelocity Map**

This map allows for the conversion of the reflection time map into a depth map. Therefore, it is essential to know the velocity regime in the studied area. Sources used for this include acoustic logs and dynamic correlation velocities. In our study, we used average velocities to establish this map.

- **Creation of the Isobath Map**

Material constraints prevented us from manually creating the depth map. However, by digitizing the time and velocity maps, we were able to produce an isobath map. In practice, the depth map is obtained by multiplying the time map by the isovelocity map, using the following formula:

$$V = \frac{d}{t} \rightarrow d = V \times t \tag{3}$$

- **Digitization**

After drawing the curves on the positioning map, they are scanned and then transferred to the NEURAMAP software for direct digitization in a visible format. Once digitized, the maps are exported to ZUMAP-PLUS, the software used for automatic map generation and final map formatting.

## 4. Results and Interpretation

### 4.1. Sedimentological Study

The study interval for well PA in this work ranges from 2610 to 3100 meters. The objective of this study is to highlight the nature of the various formations encountered in the Albian during drilling in the study area.

The log for well PA, extending from the top of the Albian (2610 m) to 3100 m, includes five sandy/silty levels (**Figure 4**), interspersed with clay, limestone, and siltstone beds, described as follows:

- **Level 1: 2610 - 2645 m**

**Logging:** The Gamma Ray values at the top are in an intermediate range, oscillating between 75 and 110 API. These values progressively decrease to 56 API in the middle and lower sections. The resistivities recorded are high, indicating the possible presence of more resistant formations. The Density-Neutron measurements display average values, while Sonic readings are relatively low, suggesting low compaction or porosity in these areas.

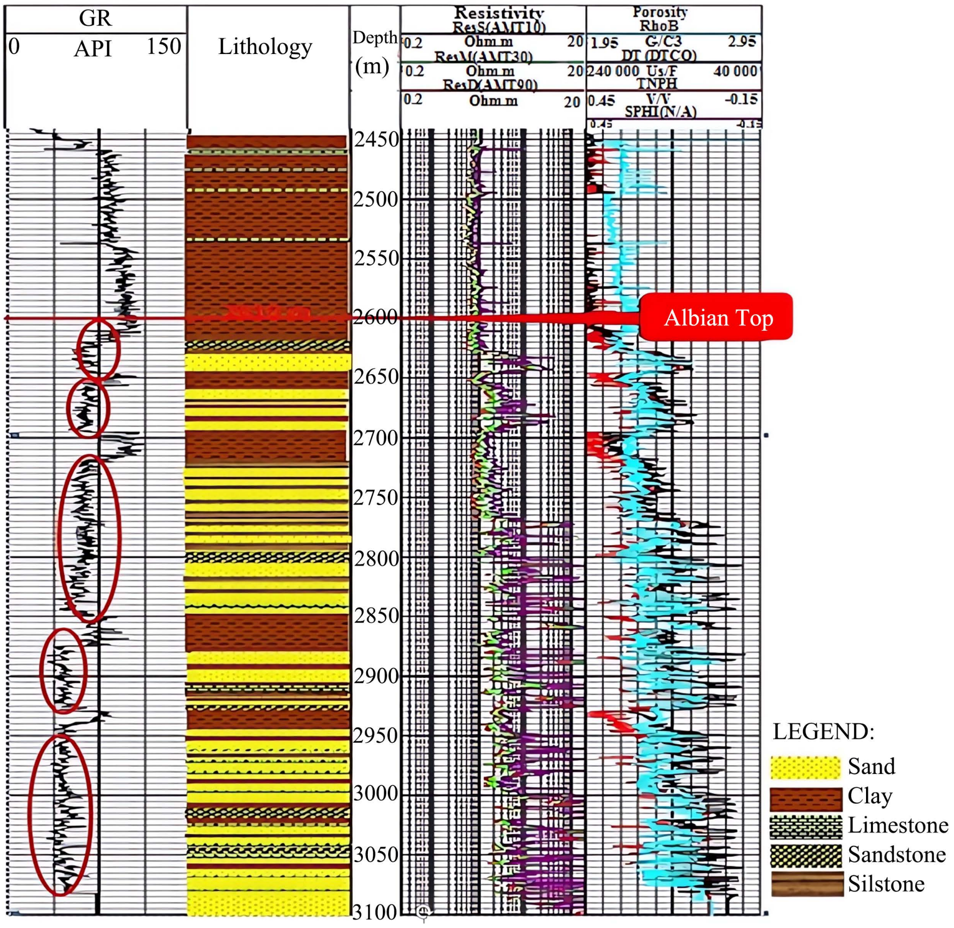


**Figure 4.** Log Signature of Well PA.

**Lithology:** The siltstone is dark gray, moderately indurated, compact, containing micaceous sand, slightly pyritic with rare limestone presence, and no oil indicators. The sandstone is light gray, with very fine to medium coarse grains, transparent to translucent, moderately sorted, subangular to subrounded, set in clayey cement, with no oil indicators. The clay is locally silty and calcareous, gray to dark gray, and compact. The kaolinite is white to light gray, friable, compact, and moderately firm.

- **Level 2: 2660 - 2695 m**

**Logging:** At this level, Gamma Ray values are average and stable, around 65 API. The Density-Neutron pair measurements, resistivities, and Sonic log show similar behavior to Level 1, suggesting continuity or homogeneity of geological properties in this well.

**Lithology:** The sand is light to off-white, transparent to translucent, with medium to very coarse grains, occasionally fine with pebbles, subangular to subrounded, poorly to moderately sorted, with no oil presence. The siltstone is dark gray to off-white, moderately indurated and compact, containing micaceous sand, slightly calcareous and micropyritic, with no oil presence. The kaolinite is light gray to beige, soft to firm, friable in places, and presents a micritic texture.

- **Level 3: 2725 - 2845 m**

**Logging:** In this particularly thick Level 3, Gamma Ray values are also average, ranging between 60 and 65 API, with some peaks reaching 75 API and a sawtooth signature. Resistivities are low in the upper and middle parts, around 10 ohm·m, with occasional peaks reaching 20 ohm·m. Sonic log values are low, while the Density-Neutron pair shows average values, indicating some homogeneity in these properties.

**Lithology:** The sand is light gray to white, with transparent to granular translucent quartz grains, medium to coarse, sometimes very coarse with pebbles, poorly to moderately sorted, subangular to subrounded, with no oil indicators. The sandstone is light gray and brown, with transparent to translucent grains, medium to coarse, sometimes very coarse with pebbles, subangular to subrounded, poorly sorted, with no oil indicators. Limestone is present as small beds, light gray to white, firm to moderately hard, with a cryptocrystalline texture, in angular breaks, and rarely contains clay, sand, and dolomite, with no oil indicators. The siltstone is dark gray, moderately hard and compact, containing sand, micromicaceous to micaceous, micropyritic to pyritic, and slightly calcareous, with no oil indicators. The clay is always gray to dark gray, firm to moderately hard, with an amorphous and compact texture, and set in a silty, pyritic, and slightly calcareous cement.

- **Level 4: 2880 - 2930 m**

**Logging:** In this level, which is thinner, Gamma Ray values are even lower, ranging between 37 and 50 API. Resistivities and Density-Neutron pair values are average, while Sonic log values remain low, indicating a continuity in the observed physical property characteristics.

**Lithology:** The sandstone is light in color, approaching white, consisting of fine to medium and occasionally coarse quartz grains, subangular to subrounded, moderately sorted, set in a siliceous and pyritic cement, with no oil indicators. The sand is light gray to brown, consisting of transparent to translucent grains, medium to very coarse, with conglomerates, subangular to subrounded, poorly sorted, with no oil exposure. The limestone is light gray to white, with a cryptocrystalline texture, in angular breaks, rarely containing sand and clay, with no oil indicators. The siltstone is dark gray, brittle, with a compact structure, containing micaceous sand, slightly calcareous, with no oil exposure.

- **Level 5: 2945 - 3100 m**

**Logging:** In this level, which is as thick as Level 3, Gamma Ray values remain low, similar to the previous level, ranging between 38 and 50 API with some peaks reaching 60 API. The other logs did not show significant changes. Their behaviors are comparable to those observed in the previous level.

**Lithology:** The sand is light gray to brown, consisting of transparent to translucent grains, medium to very coarse, with conglomerates in places, subangular to subrounded, poorly sorted, with no oil exposure. The sandstone is light gray to brown, with transparent to translucent grains, medium to very coarse, subangular to subrounded, poorly sorted, with no oil indicators. The siltstone is dark gray, moderately hard, amorphous, subcompact to compact, containing sand, micromicaceous to micaceous, micropyritic to pyritic, and slightly calcareous, with no oil indicators. The clay is locally silty and calcareous, gray to dark gray, with an amorphous and subcompact to compact structure. The limestone is light gray, firm to moderately hard, with recognizable sedimentary textures such as grainstone, mudstone, and wackestone, cryptocrystalline, containing clay and sand.

The sedimentological study reveals a lithological sequence dominated by sandy and sandstone levels interspersed with siltstones, clays, and limestones. Gamma Ray values show a general trend of decreasing with depth, while other logs indicate variability in the physical properties of the formations. The deeper levels exhibit stability in lithological characteristics but with a trend towards lower Gamma Ray values and variable resistivities.

## 4.2. Study of Seismic Profiles

### 4.2.1. Analysis of Line EW-2 and Trace NS-2

Two seismic profiles, oriented East-West and North-South respectively, were meticulously analyzed (**Figure 5** and **Figure 6**) to study the evolution of Albian formations and better understand the tectonic dynamics in the studied block. This cross-sectional approach captures the spatial complexity of geological structures, which is essential for defining reliable exploration targets in a petroleum context. Seismic analysis reveals crucial information about the continuity and nature of sedimentary facies, as well as the tectonic processes that have shaped this part of the Ivorian basin margin.

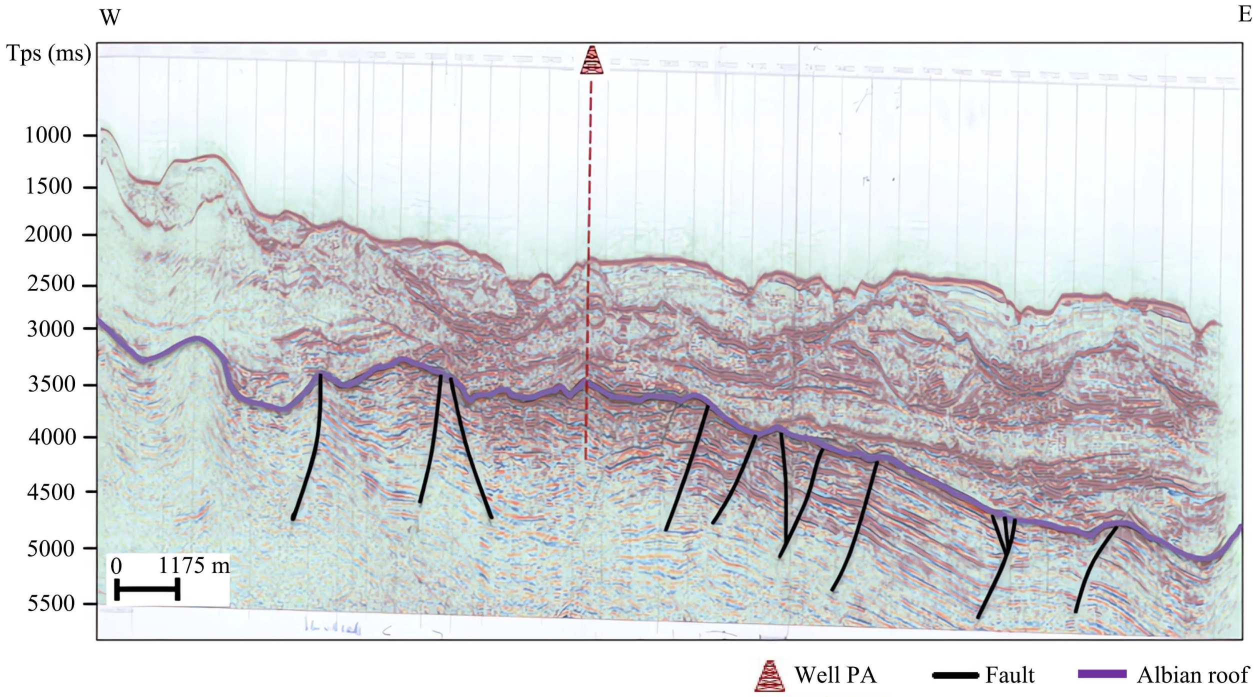


**Figure 5.** East-West seismic profile of Block A.

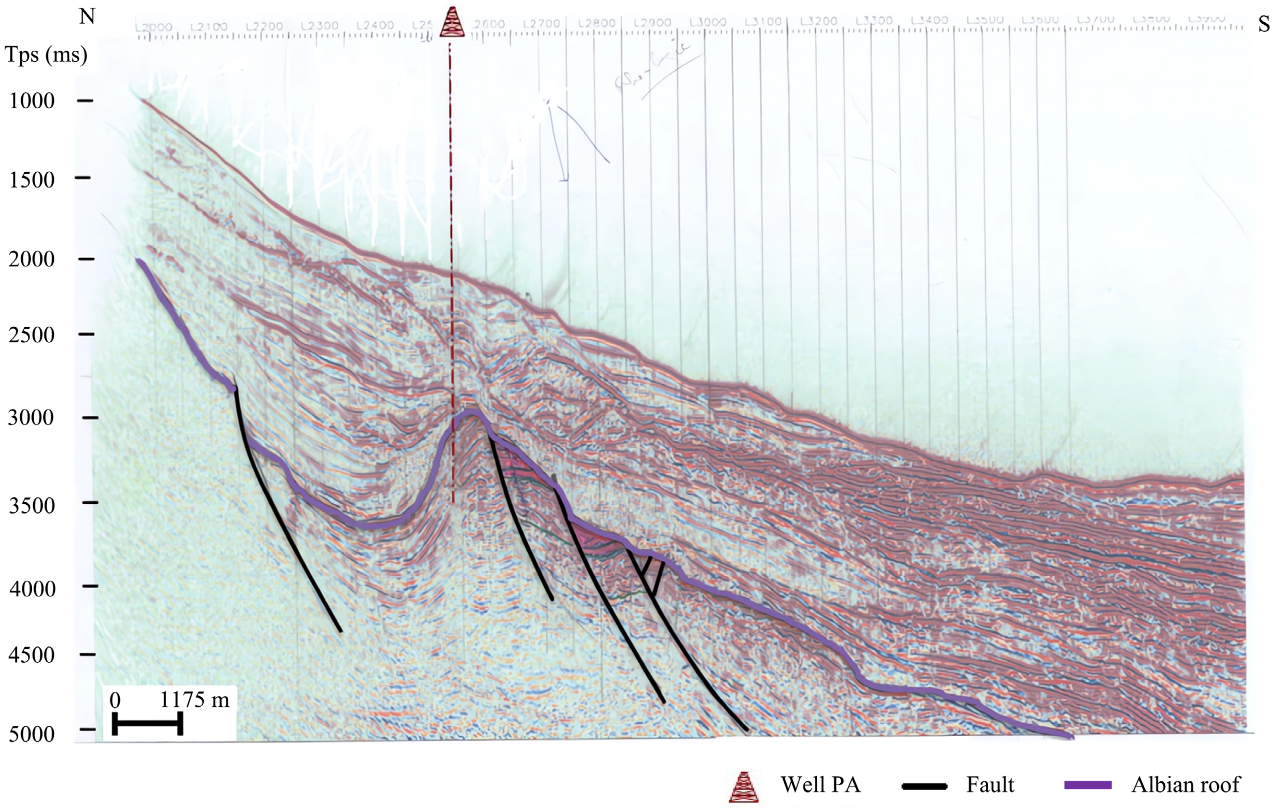


**Figure 6.** North-South seismic profile of Block.

In terms of seismic facies continuity, the reflectors observed on these profiles are mostly continuous, indicating good preservation of sedimentary deposits and relative homogeneity of depositional conditions at a regional scale. This continuity is crucial as it suggests a potential hydraulic connection across the reservoir, increasing the likelihood of finding hydrocarbon accumulations over large areas. High-amplitude reflectors present in the identified formations also indicate marked geophysical contrasts, often related to the presence of interfaces between different lithologies, such as between potentially hydrocarbon-rich reservoir rocks and more impermeable formations.

Another critical point is the gradual decrease in formation thickness observed both from West to East and from North to South. This variation in thickness could result from several factors, such as changes in tectonic or sedimentary regimes. It suggests a reduction in subsidence or a gradual distancing from the sediment source, which affects the quality and distribution of oil reservoirs. Thicker areas indicate environments favorable for the accumulation of organic-rich sediments, thus increasing the potential for hydrocarbon generation. Conversely, areas where thickness decreases represent more oxidizing environments, less conducive to the preservation of organic matter.

Structurally, the identification of normal faults associated with rifting and oceanization processes highlights an active tectonic context. These faults play a key role in shaping structural traps that may contain hydrocarbons. Normal faults, typical of extensional contexts, create faulted blocks and spaces where sediments can compact and form potential reservoirs. Additionally, they can also facilitate the migration of hydrocarbons from deeper zones to shallower trapping structures, thereby increasing the chances of commercial discoveries in Block A.

The tectonic model in this part of the basin is therefore a determining factor for locating oil targets. Indeed, tectonics, by influencing the formation and configuration of geological structures, plays a crucial role in generating oil traps. Subsidence, erosion, and fracturing phenomena, widely observed in this area, further enhance this influence. Subsidence, by allowing rapid burial of sediments, promotes their thermal maturation and transformation into hydrocarbons. Erosion phases can create unconformity surfaces, often associated with potential reservoirs. Finally, fractures, acting as conduits for fluid migration, increase the likelihood of hydrocarbon accumulation in faulted structures or structural highs, thus forming ideal traps for reservoirs.

Thus, the combination of the evolution of Albian formations, the continuity of seismic facies, and the identified tectonic dynamics in Block A provides a promising geological framework for oil exploration. These elements suggest that the block has interesting potential, although further studies are needed to refine the understanding of trapping and hydrocarbon migration mechanisms.

#### 4.2.2. Analysis and Interpretation of Isochrone, Isovitesse, and Isobath Maps

Following the interpretation of seismic profiles, the development of time maps (isochrones), velocity maps (isovitesse), and depth maps (isobathes) at the top of the Albian has highlighted the main geological structures in the area, with the goal of identifying potential oil prospects. These maps, created with intervals of 100 ms for isochrones, 10 m/s for isovitesse, and 100 m for isobathes, provide crucial information for assessing the potential for hydrocarbon discovery.

The isochrones displayed on the map (**Figure 7**) show a reduced and relatively regular spacing, which is a direct indicator of a steep geological slope. This significant dip of the geological formations in Block A is a crucial parameter to consider in the analysis, as such geometry can strongly influence the migration and trapping of hydrocarbons. A steep dip is often associated with environments where tectonics have played a significant role, altering the stratification of sedimentary layers and increasing the likelihood of creating structural traps.

The faults identified, oriented SW-NE, align with the direction of the isochrones, suggesting a strong tectonic interaction in the formation of these structures. These faults can play a dual role: they may either facilitate the migration of hydrocarbons from deeper zones or act as traps if associated with impermeable formations. This underscores the need for a detailed study of these faults to determine if they are conducive to hydrocarbon accumulation, as their role in the block is critical for the success of future exploration efforts.

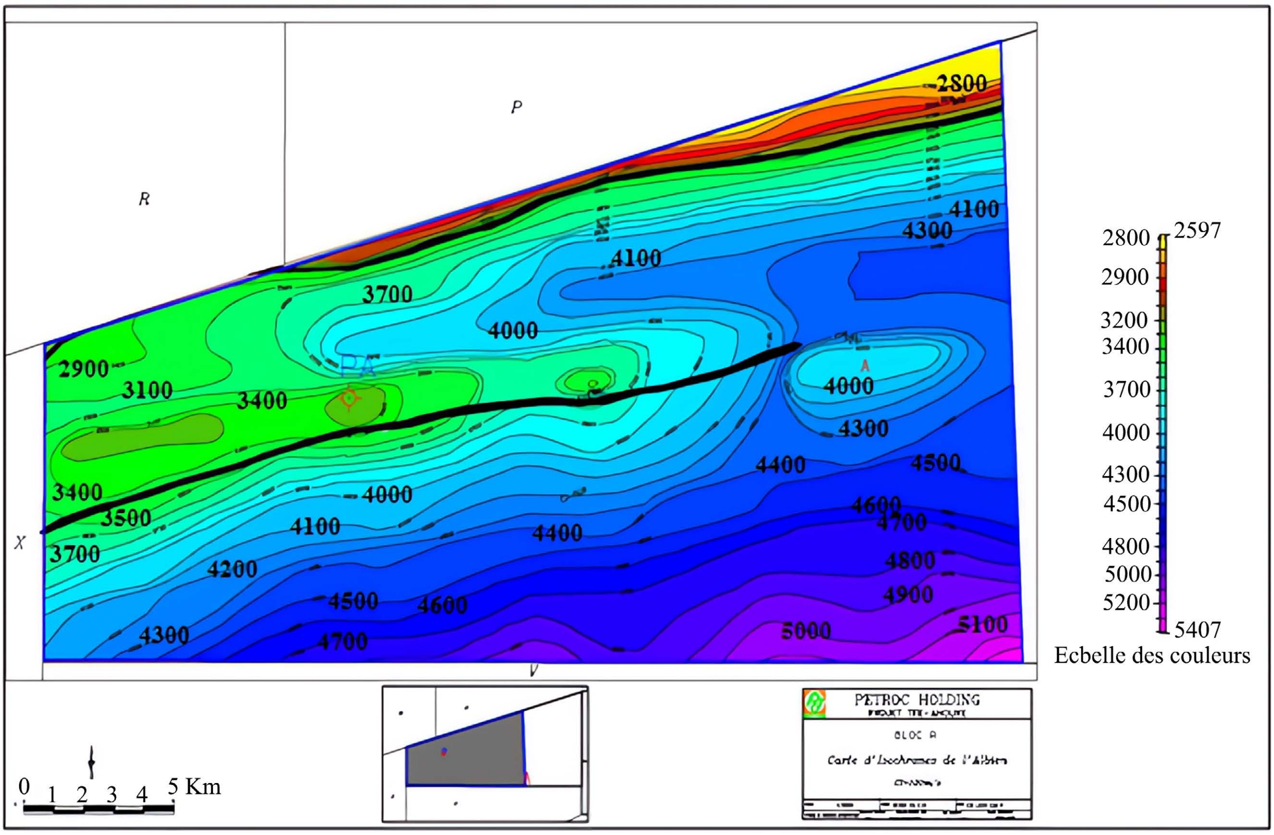


**Figure 7.** Isochrone Map at the top of the Albian.

To the south of the study area, the top of the Albian shows a significant deepening, with values ranging between 4500 ms and 5300 ms. These depth variations, coupled with uniform curves and regular contours, are positive indicators of stable and predictable geology, which facilitates the planning of exploratory drilling. Such a configuration may suggest continuous reservoirs, less fragmented by secondary faults, thus providing simpler targets for exploration operations.

In the central part of the map, the observed irregularities, in the form of concentric curves associated with shorter times (3300 ms), highlight elevated areas. These structural highs are often considered very attractive prospects in oil exploration, as they can form natural stratigraphic traps where hydrocarbons migrate and accumulate. However, their concentric nature and the gradual evolution from West to East indicate a decrease in elevation, which could signal lithological transitions or changes in tectonic conditions. These transitions must be considered to assess the continuity of potential reservoirs.

Moving towards the North, the variation in time, which increases and then decreases to reach 2700 ms, reflects more pronounced slope changes. The closely spaced contour lines in this part of the map suggest steeper tectonic gradients, potentially caused by faults or greater deformations. This type of geological configuration can be both an advantage and a challenge: on the one hand, slope gradients can indicate effective structural traps, but on the other hand, the tectonic complexity can make it more difficult to precisely identify areas where hydrocarbons have accumulated.

Thus, this isochron map, by providing detailed information on slopes, faults, and structural highs, offers an overview of geological structures favorable to oil exploration. However, the tectonic complexity suggests that further studies will be necessary to refine potential targets and maximize the chances of success.

The isovelocity map at the top of the Albian reflects an average velocity regime, used for time-depth conversion, which is a key element of geophysical interpretation. The conversion of the isochron map into an isobath map (**Figure 8**) allows the translation of seismic wave travel times into geological depths, thus providing a more accurate picture of underground structures. This step is crucial for a realistic assessment of oil prospects, as it reduces uncertainties related to depth calculations and improves the localization of potential drilling targets.

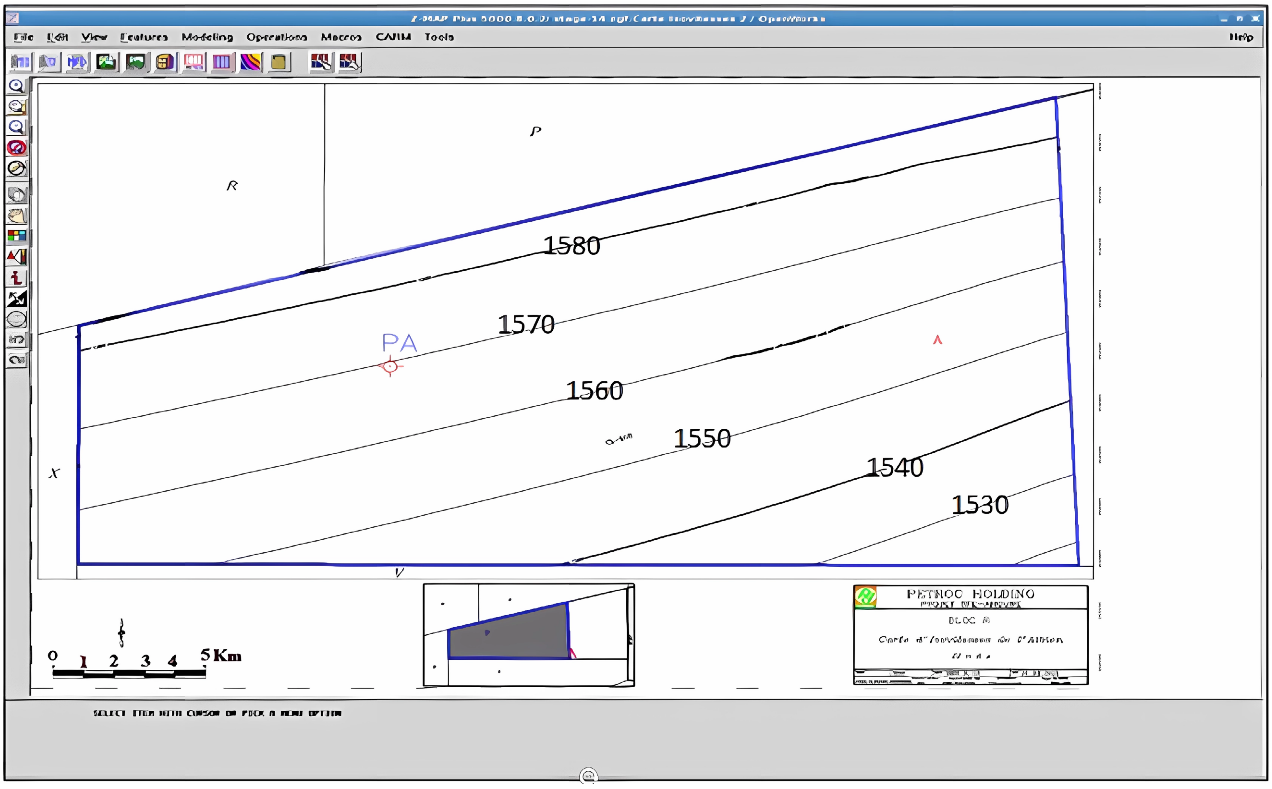


**Figure 8.** Isovelocity map at the top of the Albian.

On this map, the subparallel and regular contours, with almost identical spacing, indicate a uniform evolution of seismic velocities in the studied block. This reflects a certain geological stability in the distribution of velocities, suggesting that the area is largely homogeneous in terms of lithology at this depth. However, the regularity of the contours does not imply the absence of structures of interest; quite the opposite.

The wave propagation velocities in this block range between 1540 m/s and 1590.77 m/s, which is relatively low for geological formations at these depths.

These low velocities are often a sign of less consolidated sediments, which can be interesting indicators for oil exploration. Indeed, in some cases, reduced velocities may be associated with quality reservoirs, as they reflect porous and permeable sediments conducive to the presence of hydrocarbons.

Additionally, these low velocities suggest the potential presence of structural anomalies, such as faults, elevated reliefs (highs), or canyons. Faults, in particular, can play a crucial role in the migration and trapping of hydrocarbons. Elevated reliefs and canyons, on the other hand, are often associated with favorable conditions for the accumulation of sediments rich in organic matter, which could indicate areas with high hydrocarbon potential. The presence of these structural anomalies thus requires further investigation to confirm their role in the formation of petroleum traps.

Thus, although the measured velocities are moderate, they reveal encouraging signs of a geology favorable for oil exploration. The potential structural anomalies detected through velocity variations pave the way for more in-depth geophysical studies, to better understand the configuration of the area and maximize the chances of success in future drilling.

The isobath map reveals a morphology similar to that observed on the isochron map (**Figure 9**), further reinforcing the consistency of the geological data and structural interpretation of the studied area. It highlights, in the center, elevated reliefs, particularly pronounced in the West compared to the East. This asymmetry suggests a complex tectonic dynamic, with a more pronounced influence of geological forces in the western part of the block. These central reliefs could indicate structures favorable to the accumulation of hydrocarbons, as structural highs are often areas conducive to the formation of petroleum traps, especially when faults are present to act as confining structures.

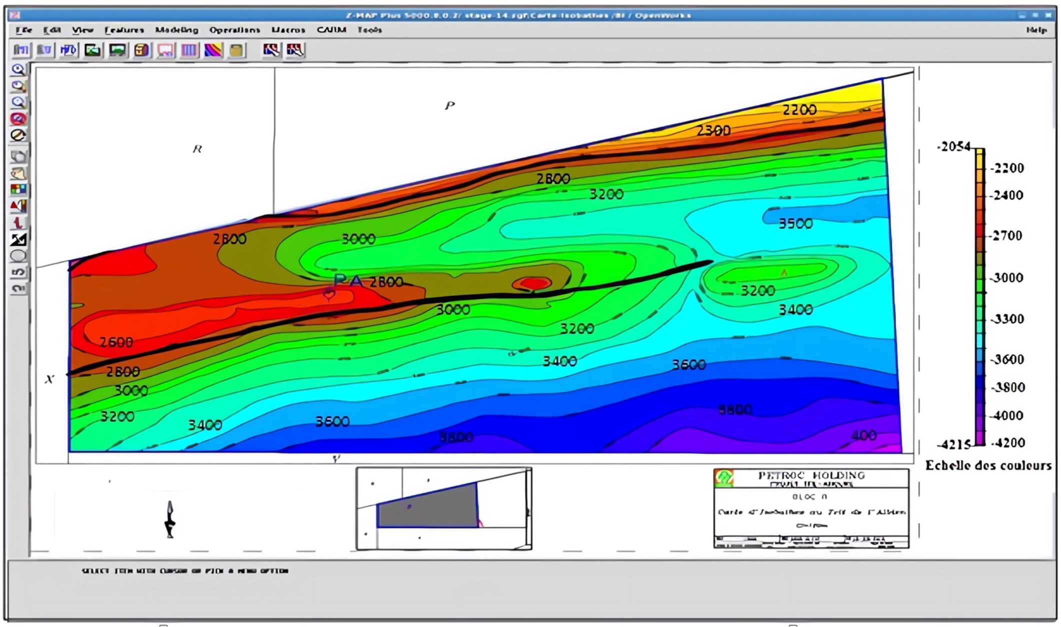


**Figure 9.** Isobath map at the top of the Albian.

The southern part of the map, characterized by a uniform morphology and a gentler slope, shows values between 3500 m and 3900 m. This area, with lighter slopes, indicates a more tectonically stable zone, less affected by recent deformations. It also reflects more favorable sedimentary conditions for the formation of continuous and homogeneous reservoirs. The gentleness of the slope in this part makes access to the reservoirs easier, reducing the technical challenges related to exploitation.

In contrast, the northern part shows tighter contours, suggesting a much steeper slope. These drastic slope changes can be associated with intense tectonic processes, such as fault movements. According to [12], this area corresponds to the Saint Paul Fault, a major tectonic structure that could play an important role in the migration and concentration of hydrocarbons. Faults, especially those of this magnitude, can serve both as conduits for the migration of hydrocarbons from deeper areas and as traps when associated with favorable formations.

**Figure 9**, incorporating isobath data, clearly shows the shallowest areas of the basin, delineated by yellow or brown colors, and the deepest areas, represented in blue. This distinction between higher reliefs and deeper zones is crucial for identifying petroleum prospects. Shallow areas may offer more accessible and economically viable targets for exploratory drilling, while deeper zones, although associated with higher risks and greater operating costs, may contain hydrocarbon-rich reservoirs, especially in rapidly subsiding environments where organic matter accumulates and matures more efficiently.

### 4.2.3. Highlighting Prospects

The 3D seismic interpretation has highlighted two major prospects of interest (prospect 1× and prospect 2×), which show strong potential but require further analysis through future complementary studies (**Figure 10**). These additional studies will help better characterize the geological conditions, reduce uncertainties, and optimize development strategies for efficient oil production.

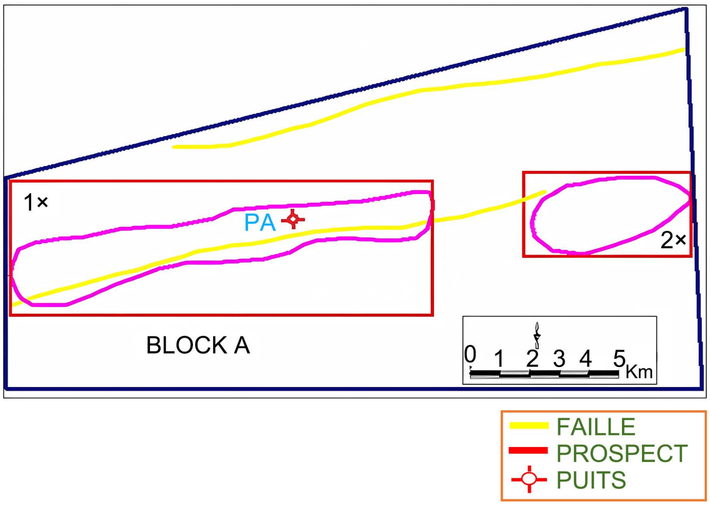


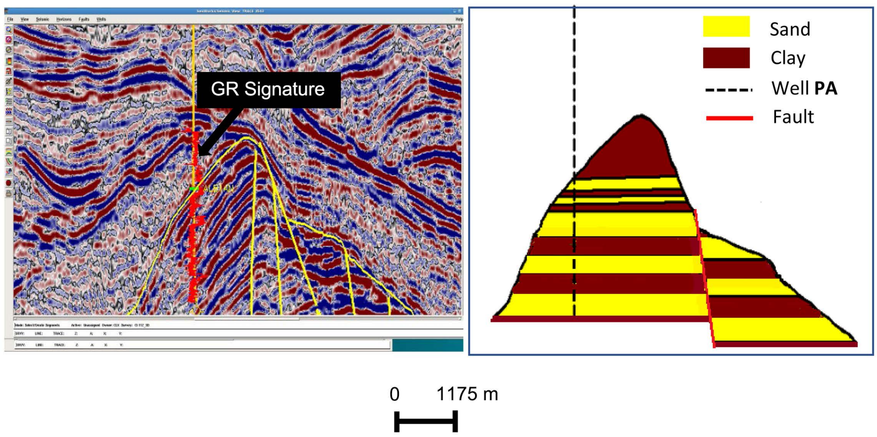
**Figure 10.** Map of spatial distribution of seismic anomalies.

The first prospect 1×, where well PA was drilled, stands out due to a prominent closed Albian relief, compartmentalized by a series of normal faults with a displacement towards the south. This geological configuration is particularly interesting because normal faults create natural compartments that, if impregnated with hydrocarbons, could function as effective traps. The position of well PA, located at the center of this structure, reinforces the hypothesis that this area is conducive to hydrocarbon accumulation. This type of geological trap, although complex, is known to yield good results when properly sealed and charged, making it a priority target for profitable oil production (Figure 10).

The second prospect 2×, located to the east of the structural map, is a small relief aligned on the same axis as prospect 1× (Figure 10). Although smaller in size, its alignment with the first prospect may suggest a favorable geological continuity. This type of configuration, with an alignment of structures, may indicate similar tectonic mechanisms that influenced the formation of both traps, suggesting exploitable oil potential. Although smaller, prospect 2× could benefit from the favorable conditions observed in prospect 1×, particularly if similar hydrocarbon migration systems are present. This relief could thus represent an interesting opportunity for future explorations, especially if the analysis of faults and traps in the area reveals connections that favor the migration of hydrocarbons from deeper areas.

Outside of the two structural highs identified in block A, no other culmination of significant interest has been observed in this area. The absence of additional structures reducing the prospects for discovering new reservoirs shows that the petroleum potential of the region is mainly concentrated on these two already identified prospects.

To assess the likelihood of success for the prospects highlighted in this study, we considered three essential parameters (Figure 11):



(a)

(b)

Figure 11. Highlighting the lithological and structural characteristics of prospect 1×. (a) Evolution of the GR signature in well A of prospect 1× (3D view); (b) Sketch of the lithological facies encountered during drilling.

- **Reservoir presence**: This criterion is confirmed, as a reservoir was encountered in the PA well. The quality of this reservoir could play a key role in the future success of any exploitation, since the effective presence of reservoirs is a determining factor for hydrocarbon recovery.
- **Trapping**: It is deemed favorable near the PA well, where the structure is well compartmentalized by normal faults, creating geological traps conducive to hydrocarbon retention. The structure's ability to trap and contain hydrocarbons is a fundamental factor in ensuring an economically viable accumulation.
- **Hydrocarbon charge**: Although sands are present, they are not impregnated with hydrocarbons, and no evidence of hydrocarbons has been discovered to date. This suggests an insufficient hydrocarbon charge or unfavorable migration conditions, significantly limiting the chances of discovering exploitable resources. This factor could be a major obstacle to the success of exploration projects in this area and may require further investigation to better understand fluid dynamics in the region.

## 5. Discussion

The results obtained in this study reveal that the Albian deposits in the studied area are primarily composed of detrital sediments such as clay, sand, and sandstone, with rarer occurrences of limestone and siltstone. These findings are consistent with previous work by [12], which also described these sediments as predominantly clastic in origin. They classify them into two main categories: coarse clastics of continental origin and finer clastics, including marine intercalations. These deposits are characteristic of environments associated with rift phases, where tectonic activity and fault movements play a key role in sedimentation. Rift activity, in particular, promotes the deposition of these sediments in lacustrine, deltaic, or coastal environments.

These results also confirm the observations made by [13], who demonstrated that the Albian deposits consist mainly of detrital sediments. They observed a sedimentary sequence composed of coarse and fine sandstone, often poorly consolidated, reaching a thickness of up to 20 meters, alternating with slightly silty gray clays. This type of stratigraphic sequence is typical of depositional environments where marine influence is intermittent, creating an alternation of transgressive and regressive phases.

In terms of lithological composition, the results of this study are also in agreement with the work of [14], who, during the lithological and petrophysical characterization of various horizons, confirmed that the Albian is primarily composed of detrital sediments. They identified different horizons: the blue clayey horizon, the very sandy and gritty green horizon, the sandy and gritty yellow horizon, as well as the pink horizon, which is often gritty-limestone or gritty-clay. These results highlight the lithological diversity of the Albian, presenting varied facies depending on depositional environments and diagenetic conditions, thus influencing the reservoir potential of different units.

Furthermore, several case studies in similar basins, such as those conducted in the Gulf of Guinea Basin and offshore Nigeria [3], confirm that the depositional environments during the Albian in these regions were also dominated by detrital clastic sediments with marine intercalations, reinforcing the idea that this period was largely marked by tectono-sedimentary conditions favorable to the formation of hydrocarbon reservoirs. These environments, often characterized by episodes of rapid subsidence followed by periods of continental and marine deposition, played a crucial role in creating effective traps for hydrocarbons.

However, there is a divergence compared to the work of [15], who conducted research on the Eastern margin of Abidjan. They reported that the Albian in this area is essentially clayey, with a more limited presence of sand. This difference could be explained by local variations in depositional environments within the Ivorian sedimentary basin. The Eastern margin of Abidjan may have been subjected to conditions more favorable to clay accumulation, for example in deep marine environments or low-energy basins, while areas closer to the rifting zone would have allowed the accumulation of coarser sediments such as sand and sandstone.

From a seismic perspective, two key elements confirm the presence of traps in the Ivorian basin during the Albian:

**Continuous seismic reflectors**: The analysis of seismic profiles reveals the continuity of high-amplitude reflectors, particularly in areas where normal faults associated with rifting are present. These continuous reflectors, observed in East-West and North-South directions, indicate a certain coherence of the geological layers, which favors the creation of closed structural traps, As highlighted by [16] in his work, fractures play a crucial role in the generation, migration, accumulation, and preservation of hydrocarbons. The identified geological formations show thickness variations, with a notable decrease in sediment thickness from West to East and North to South, confirming the presence of structural reliefs and potential traps.

**Geometry of normal faults**: The 3D seismic data interpreted in this study highlight normal faults oriented SW-NE, responsible for the geological compartmentalization observed in the Albian stage. These faults create tilted blocks and structural highs, such as the identified highs, which serve as potential hydrocarbon trapping zones. The presence of these faults is consistent with rifting and oceanization environments, where normal faults play a crucial role in creating favorable trapping structures for hydrocarbon accumulation. This tectonic configuration, confirmed by the studies of [12], reinforces the idea that Albian reservoirs are predominantly associated with structural traps in the Ivorian basin.

## 6. Conclusion

The study highlighted the sedimentological and geophysical characteristics of the Albian formations in Block A of the San Pedro margin. Five distinct levels of sandy and sandstone formations, interspersed with clays, limestones, and siltstones, were identified between 2610 m and 3100 m depth. Although the analyses did not reveal direct hydrocarbon impregnation, seismic interpretation identified two significant structural prospects, with normal faults and reliefs favorable for hydrocarbon trapping.

## Acknowledgements

We would like to express our deep gratitude to the General Directorate of PETROCI, particularly the Exploration Directorate, for enabling the completion of all the analyses.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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