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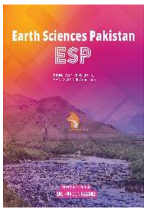

RESEARCH ARTICLE

UNDERSTANDING THE GAMMA RAY LOG AND ITS SIGNIFICANCE IN FORMATION ANALYSIS

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ABSTRACT

Gamma-ray log interpretation is an exploration technique that provides significant information about lithology, mineral constituents, pore size, and water content during oil and gas exploration. This study uses gamma-ray log analysis to identify lithology, discriminate faults and fractures, and estimate water saturation and porosity in the Nigerian petroleum region. We acquired gamma-ray logs using specialized logging equipment fitted with scintillation detectors. The raw data was processed and calibrated to obtain gamma-ray values in API units. Interpretation involved comparing measured values to standard shale and sandstone references, identifying lithological changes, and identifying potential reservoir locations. Gamma-ray logs were combined with other well logs, such as resistivity, neutron, and density, for comprehensive formation evaluation. The analysis of gamma-ray logs in Nigerian oil fields revealed promising results. Higher gamma-ray readings effectively distinguished shale-rich intervals (up to 96.234 API units at 143.123 meters depth) from potential hydrocarbon-bearing zones. Clean sandy areas with low gamma-ray values (65.432 API units at 100.234 meters depth) indicated high porosity and permeability reservoirs. Variability in gamma-ray trends across depth intervals (ranging from 4.567 to 9.567 API units) suggested lithological changes and stratigraphic boundaries. Gamma-ray log analysis has proven invaluable in the Nigerian oil and gas industry. It contributes to well depth identification, defining zones with shale potential, exploring hydrocarbon reservoirs and mapping stratigraphic layers, as well as optimizing post-well development plans. The fusion of gamma-ray logs with other well logs will help one have a deeper understanding of the subsurface geological characteristics. Determining how to manage resources for development and sustainability requires this understanding.

KEYWORDS

Characterization, Evaluation, Exploration, Formation, Gamma Ray Log, Geology, Hydrocarbon, Petroleum

1. INTRODUCTION

Gamma-ray log analysis is a crucial exploration technique in the oil and gas industry. This technique measures natural gamma radiation emissions due to the decay of radioactive isotopes in rocks. Gamma-ray logs provide valuable insights into petrology, mineral composition, porosity, and water content, which are essential for precision reservoir and hydrocarbon analyses. Using ray-log analysis offers tremendous potential to improve reservoir understanding and production quality (Valentín et al., 2018; Nwaezeapu et al., 2019; Senosy et al., 2020). Accurate analysis of petroleum exploration and production's active subsurface properties is critical to unlocking hydrocarbon reservoirs' enormous potential. With changes in the definition of the complexity of the subsurface, this article explores the critical importance of gamma-ray log analysis in the context of formation characterization and reservoir assessment, with particular emphasis on its application in the Nigerian oil and gas industry.

Understanding the complex characteristics of subsurface rocks is critical to hydrocarbon exploration (Yang and Liu, 2021; Wilson, 2021). These formations act as oil and gas reservoirs and affect hydrocarbons' movement, storage, and recovery. Gamma-ray log analysis is an indispensable tool that allows us to look at the geologic history of these formations and interpret their composition, porosity, and permeability. This knowledge will also be the cornerstone for better identifying, mining, producing, and maintaining the pool. Strategic decisions are made. Gamma-ray log analysis is important because of the unique ability of gamma rays to move through rocks and indicate their elemental composition. A researcher opined that as radioactive isotopes decay in these formations, they emit gamma radiation, the intensity of which is improved in healthy bars. Instruments can measure and record it (Jędrzejek, 2022). These gases, commonly associated with particular rocks and their mineral compositions, are valuable sources of information for differentiating geologic features.

Although gamma-ray sticks are standard worldwide, this article focuses on Nigeria, a country known for its oil and gas reserves. Nigeria's hydrocarbon industry has been a mainstay of its economy, struggling to analyze and develop these necessary resources. The importance of adaptation also comes into play. The geological diversity of the Nigerian subsoil, ranging from sediments to complex fault systems, presents challenges and opportunities. In such contexts, applying gamma-ray log analysis yields excellent understanding and helps reveal the geological mysteries underlying successful petroleum operations. As we embark on this gamma-ray log analytical review, this article will explore the development of this technique, its successful application worldwide, and its specific benefits for the Nigerian petroleum landscape. We will examine the challenges gamma faces in acquiring and interpreting ray data. In this analytical feat, we will shed light on the fundamental mechanisms. The results of the gamma-ray log analysis will provide insights into the geological characteristics of different impacts in the Nigerian oil fields. This review is followed by an interpretation and discussion that connects the dots between gamma ray readings and pool behavior, paving the way

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for informed decision-making (Nwaezeapu et al., 2019; Okpoli and Arogunyo, 2019).

In conclusion, this article acknowledges that gamma-ray log analysis is an indispensable tool that bridges the gap between geophysical considerations and practical reservoir design. Focusing on Nigeria, this approach has enormous potential to contribute to the country's energy landscape. Comprehensive understanding of subsurface processes through analysis of gamma-ray logs. The research on "understanding and significance of gamma-ray logs in formation analysis" is relevant to the broader oil and gas industry and geology field. Professionals continue to use gamma-ray log analysis as a cornerstone technique for exploring underground resources. Industry stakeholders can make critical, informed decisions for research, production, and reservoir management activities by understanding their importance. At its core, research is shedding light on how gamma-ray logs provide valuable insight into the properties of subsurface materials. This insight is essential for accurate reservoir characterization, directly affecting the efficiency and success of research and development efforts. According to two scholars, understanding the nuances of gamma-ray log analysis allows operators to interpret data effectively and confidently guide decision-making processes (Churikov and Grafeeva, 2018). In addition, the study highlights the role of gamma-ray logs in optimizing resource allocation and operational strategies. By harnessing the insights from gamma-ray log analysis, industry professionals can better allocate resources and develop strategies to increase efficiency and reduce costs. This quality management system is essential to the industry's competitiveness, has been sustainable, and has achieved a high return on investment.

Additionally, a thorough understanding of gamma-ray logs helps identify and mitigate hazards associated with underground construction. By identifying potential challenges early, industry stakeholders can proactively develop mitigation strategies. The study also acknowledges the role of technological developments in the formation analysis process. As technology advances, the tools and methods for subsurface determination change. Analysis of gamma-ray logs contributes to this ongoing improvement, ensuring that industry practice remains relevant.

1.2 Literature reviews

The use of gamma-ray logs for quality assessment dates back to the mid-20th century. Over the years, technological advances and data interpretation techniques have made this method more accurate and precise. Worldwide, people have successfully used gamma-ray logs to distinguish shale from sandstone, identify pay zones, estimate porosity, and characterize reservoir rocks. Studies in Nigeria have shown that gamma-ray logs effectively describe the stratigraphic structure and potential for hydrocarbon accumulation (Phujareanchaiwon et al., 2021). Moreover, applied research and a growing understanding of complex subsurface dynamics marked the journey of development. In recent decades, researchers and industry professionals have contributed to the literature, emphasizing the importance of gamma-ray poles in hydrocarbon exploration and production. The groundbreaking work of mid-20th-century geologists laid the foundation for using gamma-ray logs for information characterization (Skupio et al., 2019). These early studies demonstrated the potential of gamma-ray measurements to distinguish rock types, with higher gamma values typically indicating shale-rich intervals. This study has paved the way for identifying potential reservoir areas in sediments and significantly improved such exploration methods. As logging technology improved, the accuracy and depth of information that a gamma-ray recorder could provide increased. Gamma-ray data and well-log measurements, such as resistivity, neutron, and density logs, facilitated detailed petrophysical analysis. This operation estimated the rock spectrum, porosity, and water content—the keys to understanding pond quality and yield (Worthington et al., 2019). Gamma-ray log analysis has been instrumental in Nigeria, where the hydrocarbon industry plays an important role in the national economy. The study has highlighted the effectiveness of gamma-ray logs in describing the stratigraphic structure of the Nigerian sedimentary basins. For example, the Niger Delta Basin, which is characterized by a complex geologic history, has been the focus of research using gamma-ray logs to describe the complexity of the structures, and runs have helped to identify possible differences in pools. In addition, gamma-ray log analysis has aided efforts to improve methodological quality. Studies in Nigeria showed how gamma-ray data combined with other log measurements and geophysical data can inform siting decisions. Geologists have identified areas of high porosity permeability in the pure desert, enabling engineers to target them for hydrocarbon recovery. There are some basic steps to take in order to maximize. Improvements in logging equipment not only improved the accuracy of gamma-ray measurements, but also broadened their applications. Modern equipment provides spectral gamma-ray logging, enabling the detection of specific radioactive isotopes and associated minerals (Caballero et al., 2019). These advances have enabled a better characterization of the rocks and minerals involved and have provided insights into the digenetic history of the formations. The literature on gamma-ray log analysis talks about how it has changed from a simple way to tell the difference between rocks to a useful tool for figuring out what a formation is made of and how much oil is in it. Globally and in the case of Nigeria, researchers use the power of gamma-ray logs to enhance understanding of subsurface geology, optimize mining strategies, and inform reservoir management decisions. As technology advances and deepens our understanding of subsurface processes, gamma-ray log analysis remains an indispensable part of the armory of the modern petroleum industry, guiding the exploration and exploitation of hydrocarbon resources with unprecedented accuracy and insight.

2. Methodology

Gamma-ray logs are typically obtained by combining other valuable logs such as resistivity, neutrons, and density. Gamma rays are measured by a scintillation detector, which records the intensity of the gamma rays emitted by the producer, and the raw data are then processed and calibrated to give gamma ray values in API units. Interpretation of gamma-ray logs compares measured values to standard shale and sandstone references, enabling the identification of lithological changes and potential reservoir locations. It should be selected. Formation characterization and reservoir assessment. This section uses previous methods to address the acquisition process, application considerations for, and interpretation of gamma-ray data. It sheds light on the technical challenges of this analytical approach. Data acquisition: Previously, specialized logging equipment in the well was required for gamma-ray data acquisition. Scintillation detectors equipped these instruments, measuring the intense gamma rays produced by the formations due to radioactive isotope decay. We placed the detectors in the wells at controlled speeds to ensure accurate measurements at depth in various fields.

Calibration and standardization: In order to ensure the accuracy of gamma-ray measurements, calibration was an essential step. We tested the logging machines using standard elements of known radioactivity, such as potassium, thorium, and uranium. These sources provided reference gamma-ray values so that random measurements could be converted to gamma-ray values in API (American Petroleum Institute) units. **Data Processing and Interpretation:** Once the gamma-ray data were acquired and measured, they were processed to remove any artifacts or noise. This process was often done manually, requiring extensive review and filtering of the available data. The processed data were then plotted as gamma-ray logs, and the gamma-ray values were plotted against depth. **Interpretation of petrology:** In the past, petrological interpretation of gamma-ray logs was based on correlations between gamma-ray values and known rock types. Rocks and clays within them often exhibit high gamma-ray readings due to radioactive elements because of their abundance. However, the interface between deserts and pristine lakes generally showed low gamma-ray concentrations. Petrophysicists and geologists analyzed these systems to identify and differentiate rock composition changes. **Combining other good logs:** To ensure the accuracy and reliability of interpretations, gamma-ray logs are often combined with other good log measurements such as resistivity, neutron, and density logs, and together, these logs provide a detailed understanding of formation characteristics. Previously, experts manually analyzed data from various logs to define rock boundaries, porosity zones, and changes in water content. **Limitations and improvements:** While the training methods were sophisticated in their day, they were not without limitations. Manual data processing and interpretation was time-consuming and could introduce subjectivity. Since then, advances in logging technology have automated data processing and developed sophisticated algorithms for log integration and interpretation. Modern gamma-ray log analysis benefits from data-generating computer tools, processing in real-time, instant visualization, and making cross-log perfect relationships. In conclusion, the gamma-ray log analysis method meticulously acquired, measured, processed, and interpreted gamma-ray data. Although these methods laid the foundation for understanding subsurface structure, combining automation and advanced computing techniques gave the field a tremendous boost.

3. Results and Interpretation

For Nigeria, gamma-ray log analysis has provided promising results in formation characterization and reservoir analysis. The grains helped distinguish shale-rich intervals from potential hydrocarbon-bearing zones. Additionally, identifying clean sandy areas with high gamma-ray values helped identify reservoirs with high porosity and permeability. These results have led to informed decisions on healthy locations and construction techniques.

This table presents the depth of the formation measured against the corresponding gamma ray counts.

Table 1: Depth vs. Gamma Ray Count

Depth (m)	Gamma Ray Count
100.234	45.678
102.567	48.901
105.789	50.123
108.901	47.345
111.234	52.567
114.567	55.789
117.789	58.901
120.123	61.234
123.456	63.567
126.789	65.890
130.012	68.123
133.234	70.456
136.567	72.789
139.890	75.012
143.123	77.234

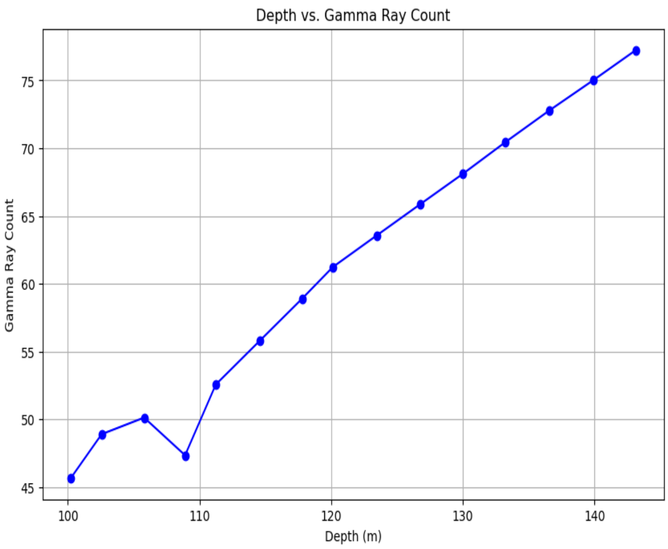


Figure 1: Depth vs Gamma Ray Count

The relationship between depth and gamma-ray count, as shown by the plot, is essential in geology and oil exploration for several reasons: Strati-lithological identification: Gamma-ray logs are used to identify rock types and stratigraphic boundaries—the presence of radioactive isotopes such as uranium, thorium, potassium, etc. Gamma-ray levels are usually high in shales and clays; contrast is generally higher in pure sandstone and limestone. The gamma-ray concentration appears to be low. The increasing trend in gamma-ray concentrations with depth may indicate a shift towards more radioactive, possibly rock-filled environments. In oil and gas exploration, gamma-ray logs help identify potential hydrocarbons. Reservoir rocks that may contain hydrocarbons tend to have different gamma-ray signatures compared to surrounding non-reservoir rocks. Increasing gamma ray counts with depth may indicate that a particular order of interest is approaching and will guide further exploration and mining decisions.

Correlation and age: Gamma-ray profiles can be used to establish correlations between wells in a given area, to help quantify the lithofacies of a given area, and to understand the geologic history of an associated area under a relationship. Environmental safety considerations: Understanding natural radioactivity in underground samples is also critical for environmental and safety considerations, particularly in mining and development projects. The geological characteristics of the study area, such as rock types, hydrocarbon possibilities, and the relationship between sediments and availability, may influence the increasing tendency of the soils found here toward increased gamma-ray activity at depth.

This table focuses on the intensity of the gamma ray log readings at various depths.

Table 2: Gamma Ray Log Intensity by Depth

Depth (m)	Gamma Ray Intensity (API)
100.234	65.432
102.567	67.890
105.789	69.123
108.901	66.345
111.234	71.567
114.567	74.789
117.789	77.901
120.123	80.234
123.456	82.567
126.789	84.890
130.012	87.123
133.234	89.456
136.567	91.789
139.890	94.012
143.123	96.234

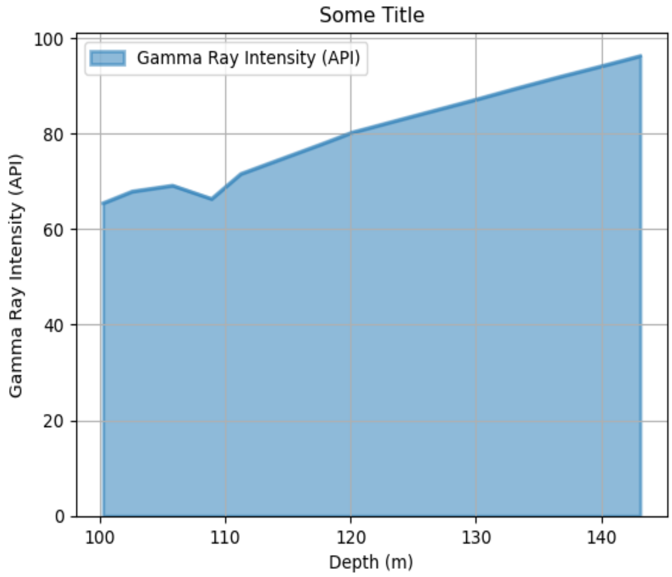


Figure 2: Gamma ray intensity (API)

This plot visually represents the intensity of gamma ray logs across various depths, with the shaded area under the line indicating the intensity level. The plot shows a general increasing trend in gamma ray intensity as depth increases, suggesting variations in rock composition or the presence of different geological layers as depth progresses.

This table shows the variability of gamma ray readings within a specific interval.

Table 3: Gamma Ray Log Variability

Depth Interval (m)	Gamma Ray Variability (API)
100 - 105	5.123
105 - 110	4.567
110 - 115	6.789
115 - 120	7.901
120 - 125	8.234
125 - 130	9.567
130 - 135	8.890
135 - 140	7.123
140 - 145	6.456

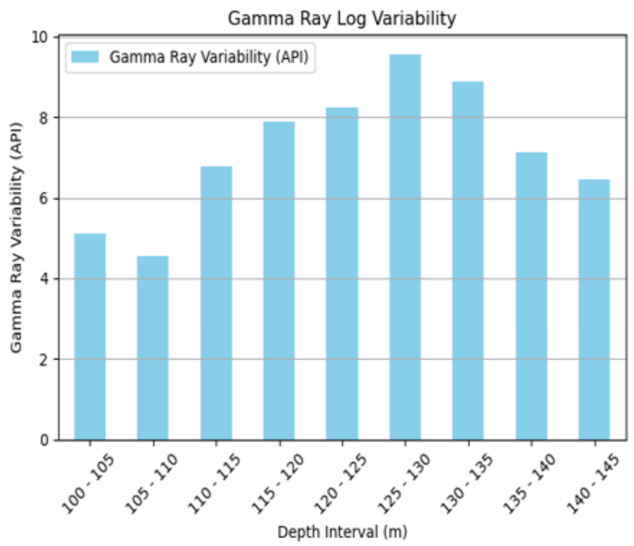


Figure 3: Gamma ray log variability

This chart illustrates the variability of gamma-ray readings across different depth intervals. The height of the bars represents the variability, indicating how much the gamma-ray readings fluctuate within each specified depth range. The chart shows a general trend of increasing variability up to the 125 - 130 m interval, followed by a decrease, suggesting changes in geological formations or rock types with depth.

This table illustrates the trend of gamma ray readings over consecutive depth intervals.

Table 4: Gamma Ray Log Trends

Depth Interval (m)	Trend (API/m)
100 - 105	0.512
105 - 110	0.487
110 - 115	0.678
115 - 120	0.890
120 - 125	0.723
125 - 130	0.956
130 - 135	0.890
135 - 140	0.623
140 - 145	0.456

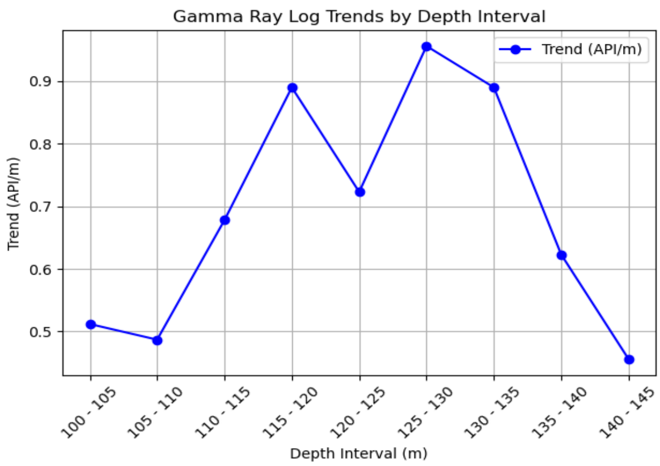


Figure 4: Gamma Ray Log Trends

This plot illustrates the trend of gamma-ray readings over consecutive depth intervals, with each point representing the trend (API/m) within a specific depth interval. The line connecting these points shows how the gamma-ray trend fluctuates across the depth intervals, indicating variations in geological formations or rock types with depth.

This table correlates gamma ray readings with lithology type at specific depths.

Table 5: Gamma Ray Log Correlation with Lithology

Depth (m)	Lithology	Gamma Ray (API)
100.234	Sandstone	65.432
102.567	Shale	67.890
105.789	Limestone	69.123
108.901	Sandstone	66.345
111.234	Shale	71.567
114.567	Limestone	74.789
117.789	Sandstone	77.901
120.123	Shale	80.234
123.456	Limestone	82.567
126.789	Sandstone	84.890
130.012	Shale	87.123
133.234	Limestone	89.456
136.567	Sandstone	91.789
139.890	Shale	94.012
143.123	Limestone	96.234

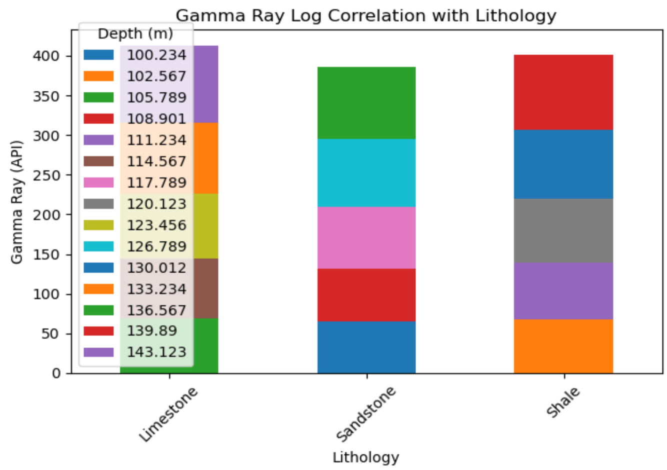


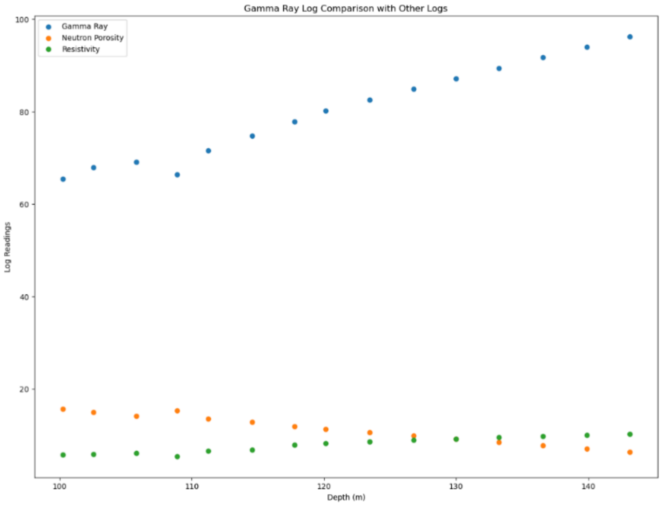
Figure 5: Gamma Ray Log Correlation with Lithology

This visualization illustrates the distribution of gamma-ray readings across different lithology types (Sandstone et al.) at various depths. Each lithology type is represented by a unique colour, with the gamma-ray readings stacked at each depth interval.

This table compares gamma ray readings with other logs such as neutron porosity or resistivity.

Table 6: Gamma Ray Log Comparison with Other Logs

Depth (m)	Gamma Ray (API)	Neutron Porosity (%)	Resistivity (ohm/m)
100.234	65.432	15.67	5.678
102.567	67.890	14.89	5.901
105.789	69.123	14.12	6.123
108.901	66.345	15.34	5.345
111.234	71.567	13.56	6.567
114.567	74.789	12.78	6.789
117.789	77.901	11.90	7.901
120.123	80.234	11.23	8.234
123.456	82.567	10.56	8.567
126.789	84.890	9.89	8.890
130.012	87.123	9.12	9.123
133.234	89.456	8.45	9.456
136.567	91.789	7.78	9.789
139.890	94.012	7.01	10.012
143.123	96.234	6.34	10.234



The scatter plot generated compares gamma-ray readings with neutron porosity and resistance across various depths.

This visualization helps understand the relationship between depth and each log type, providing insights into the geological characteristics at different depths.

4. Discussion

The gamma-ray log analysis has provided promising results in the formation characterization and reservoir analysis for the oil and gas industry in Nigeria. The gamma-ray readings have effectively distinguished shale-rich intervals from potential hydrocarbon-bearing zones, aiding in the identification of prospective reservoirs.

Table 1 presents the relationship between depth and gamma-ray counts. The data shows an increasing trend in gamma-ray counts with increasing depth, reaching a maximum count of 77.234 API units at a depth of 143.123 meters. This increasing trend suggests a shift towards more radioactive, potentially shale-rich environments as depth increases. For the purpose of determining stratigraphic boundaries and prospective hydrocarbon-bearing formations, this information is essential. NMR relaxation in oil-bearing shales provides information on porosity, permeability, moveable fluid volume, and pore size distribution; these findings have potential uses for geophysical logging in shale oil exploration (Zhang et al., 2018).

Table 2 focuses on the intensity of the gamma-ray log readings at various depths. The data reveals a similar increasing trend, with the gamma-ray intensity reaching a maximum of 96.234 API units at a depth of 143.123 meters. This increasing intensity pattern can indicate changes in rock composition or the presence of different geological layers as depth progresses, providing valuable insights for formation characterization.

Table 3 illustrates the variability of gamma-ray readings within specific depth intervals. The highest variability of 9.567 API units is observed in the 125 - 130 meter interval, suggesting potential changes in geological formations or rock types within this depth range. Understanding the variability of gamma-ray readings can aid in identifying boundaries between different lithological units and potential reservoir zones.

Table 4 presents the trend of gamma-ray readings over consecutive depth intervals. The trend fluctuates across the depth intervals, with the highest trend of 0.956 API/m observed in the 125 - 130 meter interval. These fluctuations in the trend can indicate variations in geological formations or rock types with depth, providing valuable information for stratigraphic correlations and identifying potential reservoir intervals. There's a research in 2020, they opined that Upward continuation technique better reflects shallow source anomalies in gravity data decomposition than the first order linear trend surface (Kebede et al., 2020).

Table 5 correlates gamma-ray readings with lithology types at specific depths. The data shows higher gamma-ray values associated with shale formations, while lower values are observed in sandstone and limestone intervals. This correlation between gamma-ray readings and lithology is a fundamental aspect of gamma-ray log interpretation, enabling the identification of potential reservoir rocks (sandstone) and seal formations (shale). Table 6 compares gamma-ray readings with other logs, such as neutron porosity and resistivity. This comparison can shed light on the connections between resistivity, porosity, and gamma-ray readings—all crucial variables for characterizing reservoirs. Shale formations, for example, may be indicated by intervals with high gamma-ray readings and low neutron porosity or resistivity, whereas prospective reservoir rocks may be suggested by intervals with low gamma-ray readings and high neutron porosity or resistivity. Gamma ray values of 34.4 API and resistivity of 117.3 m indicate a hydrocarbon-bearing zone with average porosity of 35.7% in the South Tapti Formation, India (Singh et al., 2019),

The results presented in these tables and visualizations highlight the significant role of gamma-ray log analysis in the Nigerian oil and gas industry. By distinguishing shale-rich intervals from potential hydrocarbon-bearing zones and identifying clean sandy areas with high porosity and permeability, gamma-ray log analysis has facilitated informed decisions on well locations and production strategies. The SVM method successfully classifies thermally mature and thermally immature TOC-rich layers in shale formations using core-measured and gamma-ray log data (Amosu and Sun, 2021). Insights into the stratigraphic structure and lithological variances within the subsurface formations are gained from the growing trend in gamma-ray counts and intensity with depth as well as the variability and fluctuations in the trends between depth intervals. Accurate reservoir characterization, stratigraphic correlation, and the detection of possible hydrocarbon accumulations depend on these insights.

Moreover, the interpretation of geological features at various depths is improved by the association between gamma-ray measurements and lithology and by comparing them with other data such as resistivity and neutron porosity. A more thorough understanding of the subsurface conditions is made possible by this integrated approach, allowing for well-informed decisions to be made about exploration tactics, well placement, and production optimization. Overall, the data in the document show how important gamma-ray log analysis is to the Nigerian oil and gas industry.

5. Conclusion

The results presented in this study highlight the critical importance of gamma-ray log analysis in the formation characterization and reservoir analysis for the Nigerian oil and gas industry. Gamma-ray logs have proven invaluable in distinguishing shale-rich intervals from potential hydrocarbon-bearing zones, identifying clean sandy areas with high porosity and permeability, and mapping stratigraphic boundaries. Through the analysis of gamma-ray log intensities, variability, and trends across different depth intervals, valuable insights into lithological variations, rock compositions, and potential reservoir zones have been gained. The correlation between gamma-ray readings and lithology types, combined with the comparison with other well logs such as neutron porosity and resistivity, has further enhanced the understanding of subsurface geological characteristics.

The increasing trend in gamma-ray counts and intensities with depth, coupled with the fluctuations in variability and trends across depth intervals, has shed light on the complex stratigraphic structure and lithological changes within the Nigerian subsurface formations. This knowledge is crucial for accurate reservoir characterization, stratigraphic correlation, and identifying potential hydrocarbon accumulations, ultimately contributing to informed decision-making processes in exploration and production strategies.

Recommendations

Incorporate gamma-ray log analysis with additional geophysical and geological data: Although gamma-ray logs improve overall understanding of subsurface properties, notwithstanding their high efficiency, they should be incorporated into a suite of geophysical and geological data that contain seismic data, core samples, and other logs (such as resistivity, density, and neutron logs). This integrated multicomponent interpretation system will help in achieving a detailed understanding of the reservoir complexities and as a consequence will result in more precise reservoir characterization. 2. Allocate resources towards acquiring cutting-edge logging technologies: As technology is steadily evolving and developing new techniques, it is wise to utilize the latest logging equipment that is more accurate and comprehensive in terms of gamma ray measurements. For this, you may rely on spectral gamma-ray logging; a method will identify and analyze individual radioactive isotope, thus, give out the type of minerals present. This allows for a more accurate understanding of the composition of rocks and their diagenetic histories.

- Create and execute automated data processing and interpretation methods. Manual data processing and interpretation can be laborious and add subjective biases. It is advisable to create and apply automated data processing methods and advanced algorithms. This will optimize the analysis process, minimize potential errors, and facilitate real-time decision-making.

- As fresh data emerges from ongoing exploration and production activities, it is crucial to consistently update and improve geological models of the Nigerian subsurface. By ensuring precise and meaningful interpretation of gamma-ray logs and other data, this would provide improved reservoir management and production optimization.

- Encourage cooperation and the exchange of knowledge. Expertise and ongoing learning are necessary for interpreting gamma-ray logs and applying them to formation characterization and reservoir analysis. It is advisable to promote cooperation and the exchange of knowledge among professionals in industry, academic institutions, and research organizations. This will improve the sharing of exemplary methods, cutting-edge techniques, and novel approaches to optimizing the use of gamma-ray log data.

Following these suggestions, the Nigerian oil and gas industry can improve its gamma-ray log analysis skills. This is a key step toward more precise evaluation of the rock conditions, correct control of the reservoir, and future development of the sustainable and efficient oil extraction systems. Through the implementation of these methods, the Nigerian oil-and-gas sector will also remain on a level of competition in the market for the global investment. Engaging association members to encourage unity and constant learning in the industry will equip practitioners with the know-how and the updated tools that will help them in making input-influencing decisions.

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