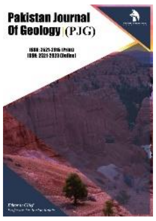
ZIBELINE INTERNATIONAL™
PUBLISHING

Pakistan Journal of Geology (PJG)

DOI: http://doi.org/10.26480/pjg.01.2024.74.79

ISSN: 2521-2915 (Print)
ISSN: 2521-2923 (Online)
CODEN: PJGABN



CrossMark

RESEARCH ARTICLE

APPLICATION OF EULER DECONVOLUTION TECHNIQUES FOR IDENTIFYING HYDROCARBON TRAPS IN THE SOUTHEASTERN NIGER DELTA BASIN USING AEROMAGNETIC DATA

Aniekan E. Ekpo[a*], Nsikak E. Bassey[a], Nyakno J George[b], Itoro C. Udo[a]

[a]Department of Geology, Akwa Ibom State University, Mkpat Enin, Akwa Ibom State, Nigeria
[b]Department of Physics, Akwa Ibom State University, Mkpat Enin, Akwa Ibom State, Nigeria
****Correspondence email: acdiamonmarkng@gmail.com***

ARTICLE DETAILS

Article History:

Received 23 September 2024
Revised 18 October 2024
Accepted 12 November 2024
Available online 15 November 2024

ABSTRACT

The Niger Delta Basin is a prolific hydrocarbon region characterized by complex geological structures such as shale diapirs, faults, fractures, and various hydrocarbon traps. This study uses Euler Deconvolution method to analyze aeromagnetic data over the southeastern Niger Delta, identifying key subsurface features critical for hydrocarbon exploration. Several geological zones with varying exploration potential are revealed. The central basin zone (latitudes 4°50'–5°10'N and longitudes 7°40'–8°20'E) shows sparse Euler solutions at depths of 2 to 5 Km, indicating a deeper basement with limited near-surface faulting. This stable zone, with its deep sediment deposits, is favorable for deep-seated hydrocarbon accumulations, particularly within the Akata Formation. In the lowland zone (latitudes 4°50'–5°00'N and longitudes 7°00'–7°40'E), fewer solutions are detected at depths of 3 to 7 Km, suggesting deeper faults or basement structures that may serve as hydrocarbon traps. The study also identifies significant shale diapirs in the western part (latitudes 5°00'–5°30'N and longitudes 7°30'–8°00'E), where clusters of solutions at 1.5 to 3 Km indicate over-pressured shales from the Akata Formation intruding upwards, creating structural traps. Additionally, several fault and fracture zones in the northwestern and eastern parts (latitudes 5°10'–5°50'N and longitudes 7°20'–7°50'E and 8°20'–8°50'E) provide potential migration pathways and trapping mechanisms. The findings suggest that targeted exploration in areas with high hydrocarbon potential, such as fault zones, shale diapirs, and structural closures, could lead to significant hydrocarbon discoveries. This study provides insights that enhance understanding of the Niger Delta Basin's complex geological framework, guiding more efficient exploration strategies in this prolific region.

KEYWORDS

Euler deconvolution, hydrocarbon exploration, hydrocarbon element, lineament, Niger Delta

1. INTRODUCTION

The Niger Delta Basin, located in southern Nigeria, is one of the world's most significant hydrocarbon provinces, known for its complex geology and prolific oil and gas reserves. The basin, formed in a tectonically active region during the separation of the African and South American plates, features a range of structural and stratigraphic traps that make it an ideal setting for hydrocarbon accumulation. Key geological units, including the Akata, Agbada, and Benin Formations, interact with numerous fault systems, diapirs, and other structural features to create a variety of subsurface environments conducive to hydrocarbon generation, migration, and trapping (Doust and Omatsola, 1990; Evamy et al., 1978).

Understanding the subsurface geology of the Niger Delta is crucial for optimizing exploration and production strategies. Traditional methods of subsurface analysis, such as seismic surveys, provide valuable data but can be limited by resolution, cost, and environmental considerations. As a result, geophysical techniques such as Euler Deconvolution and Standard Euler Deconvolution of aeromagnetic data have emerged as powerful tools for mapping subsurface structures. These techniques allow for the rapid identification of geological features such as faults, fractures, diapirs, and potential hydrocarbon traps by analyzing variations in the magnetic field (Thurston et al., 1999; Nabighian et al., 2005; Li and Oldenburg, 1996).

This study applies Euler Deconvolution methods to aeromagnetic data over the Niger Delta Basin to enhance the understanding of its subsurface structural framework. The analysis focuses on identifying key geological features—such as shale diapirs, faulting, fracture zones, and potential hydrocarbon traps—that are critical for hydrocarbon exploration. The results from the Euler Deconvolution maps provide insights into the spatial distribution, depth, and geometry of these features, which are vital for guiding future exploration efforts in the basin.

Specifically, the study aims to: identify and characterize shale diapirs and their implications for hydrocarbon trapping, particularly in areas where the ductile shales of the Akata Formation intrude into overlying formations; map fault and fracture zones to understand their roles as migration pathways or barriers for hydrocarbons; and highlight potential hydrocarbon zones associated with structural closures, such as anticlines and fault-bounded traps. The findings from this study are expected to provide a more refined understanding of the Niger Delta's subsurface geology, enabling more targeted and efficient exploration strategies.

By integrating the Euler Deconvolution maps with existing geological knowledge, this research will contributes to a comprehensive model of the Niger Delta's subsurface architecture, identifying key areas with high exploration potential. This approach will not only enhances the understanding of the basin's complex geological framework but also helps

Quick Response Code	Access this article online	
	Website: www.pakjgeology.com	**DOI:** 10.26480/pjg.01.2024.74.79

Cite The Article: Aniekan E. Ekpo, Nsikak E. Bassey, Nyakno J George, Itoro C. Udo (2024). Application of Euler Deconvolution Techniques for Identifying Hydrocarbon Traps in the Southeastern Niger Delta Basin Using Aeromagnetic Data. *Pakistan Journal of Geology, 8(1): 74-79.*

to improve the success rate of hydrocarbon exploration in this prolific region.

1.1 Location and geology

The study focuses on the southeastern onshore region of the Niger Delta Basin, covering approximately 24,650 square Km, located between latitudes 4°50'–5°50'N and longitudes 7°00'–9°00'E. This area encompasses regions within Imo, Rivers, Abia, Akwa Ibom, and Cross River States, Nigeria (figure 1). The terrain features elevation ranges from 22.4 meters in the southwestern lowlands to 187.5 meters in the northwestern and eastern highlands (figure 3). The geology of the area includes sedimentary formations such as the Akata, Agbada, and Benin Formations, underlain by a basement composed of Precambrian rocks (figure 2). To understand the subsurface structures and their implications for hydrocarbon exploration, Euler Deconvolution and Standard Euler Deconvolution maps were utilized, revealing significant information about faults, shale diapirs, and potential hydrocarbon traps within the region.

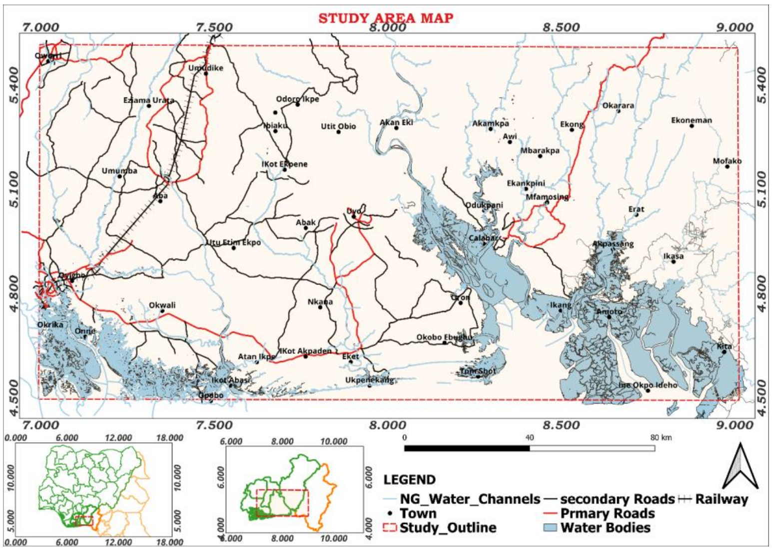


Figure 1: Location map of the study area.

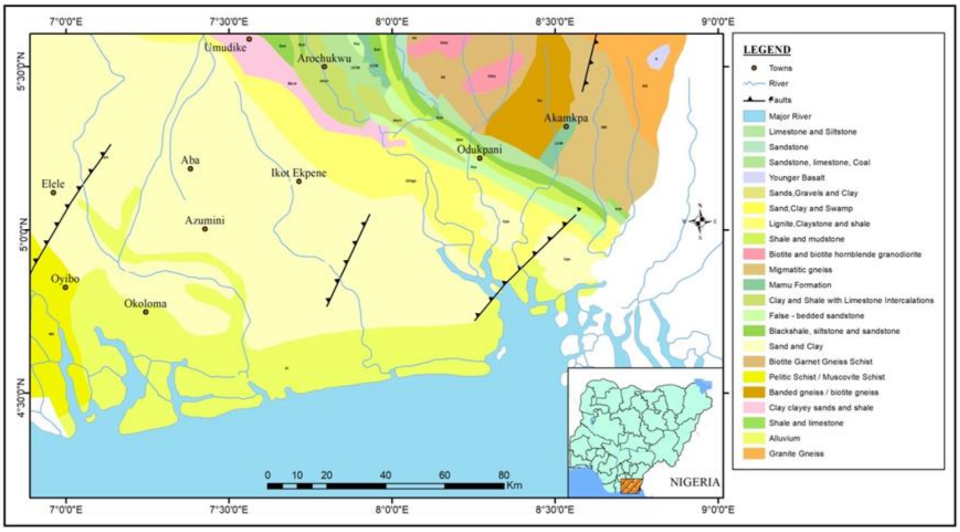
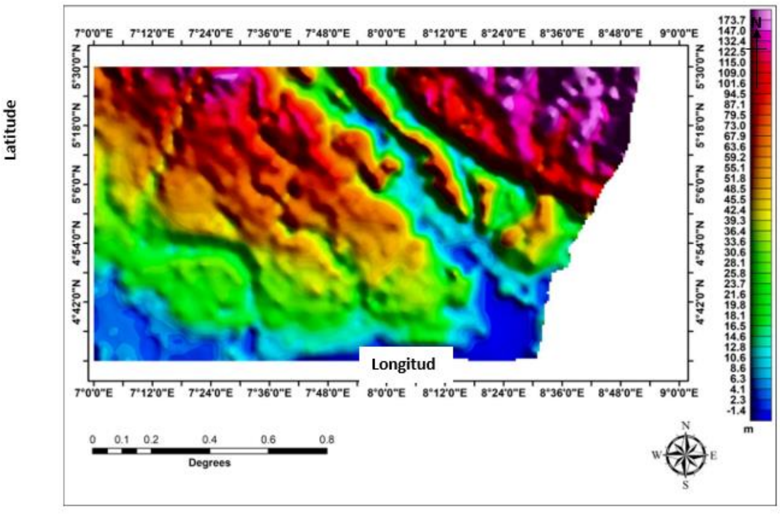


Figure 2: Geologic map of the study area (Ekpo et al., 2024a).

(a)



Cite The Article: Aniekan E. Ekpo, Nsikak E. Bassey, Nyakno J George, Itoro C. Udo (2024). Application of Euler Deconvolution Techniques for Identifying Hydrocarbon Traps in the Southeastern Niger Delta Basin Using Aeromagnetic Data. *Pakistan Journal of Geology, 8(1): 74-79.*

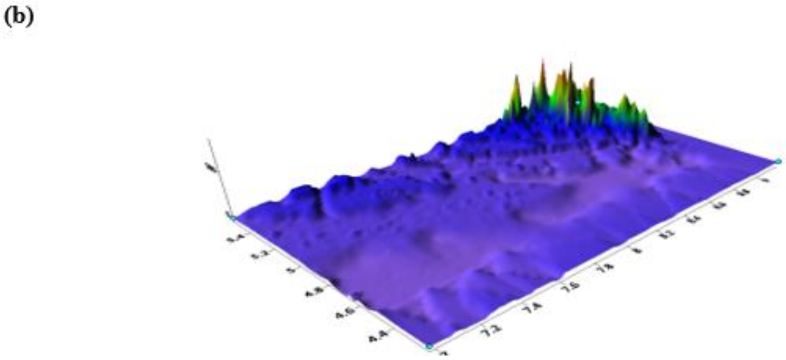


Figure 3(a): Topographic map of the study area. **(b)** 3D view of topographic map of the study area (USGS).

2. MATERIALS

The aeromagnetic data acquired by Nigerian Geological Survey Agency (NGSA) was used for the study. The materials used for this study include eight (8) magnetic sheets of 321, 322, 323, 324, 329, 330, 331 and 332. Oasis Montaj version 8.4, ArcGIS (version 10.1), and Surfer software (version 13) were employed in analyzing the data.

2.1 Data Acquisition

The airborne data was acquired and assembled by Fugro Airborne Surveys, Canada between 2005 and 2010. These data were collected using Flux-gate proton precession magnetometers and the Flux- Adjusting surface data assimilation system with flight-line space of 0.1 km, tie line space of 0.5 km and terrain clearance ranging from 0.08-0.1 km along 826,000 lines. The observed potential field data were of very high resolution when likened to the 1970 aero-geophysical data. These recent potential field data were noticed to be suited for mineral and petroleum investigations as well as geological mapping (Ekpo et al., 2024b).

The International Geomagnetic Reference Field (IGRF) correction was applied to the magnetic data set to remove the regional component of the Earth's magnetic field, while isolating the local magnetic anomalies that are of interest in geophysical exploration. The IGRF is a mathematical model that represents the Earth's main magnetic field, which is largely generated by processes in the Earth's core. The model is updated every five years and provides the expected magnetic field at any location on the Earth's surface. The IGRF correction involves calculating the magnetic field using the IGRF model at the survey locations and subtracting this regional field from the observed data. This leaves the residual magnetic anomalies, which are more directly related to local geological features. The data used for this study were processed to the form of Total magnetic gridded data displayed as imageries in colour raster format (Figure 4).

Reduction to Equator (RTE) being a processing technique used to simplify the interpretation of magnetic data by centering magnetic anomalies directly over their causative bodies was applied to the data. Magnetic anomalies can appear skewed or offset due to the inclination and declination of the Earth's magnetic field, particularly at lower latitudes. RTP mathematically transforms the observed magnetic data to simulate what it would look like if the Earth's magnetic field were vertical (as it is at the magnetic poles or equator). The process involved adjusting both the amplitude and the phase of the magnetic field components. The resulting RTP data have anomalies that are centered over their sources, making it easier to correlate magnetic anomalies with subsurface structures.

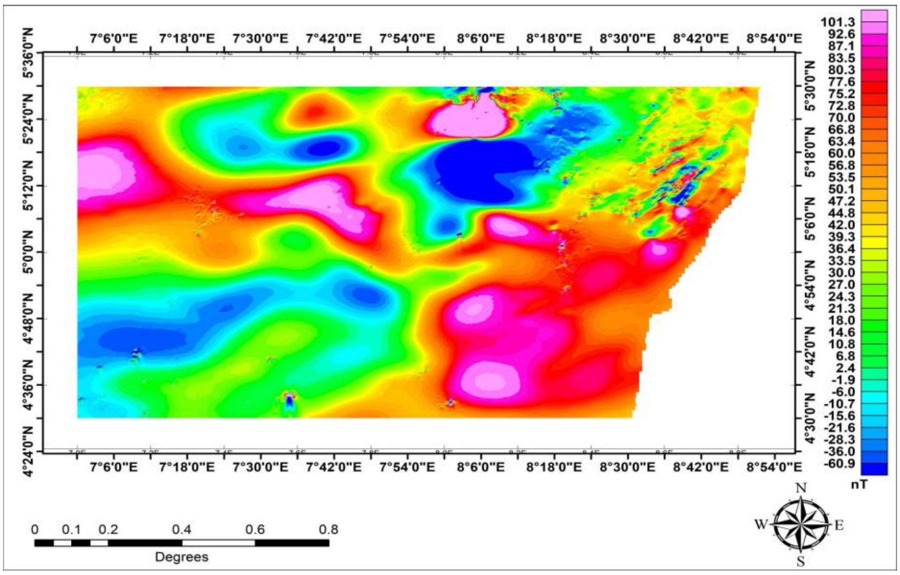


Figure 4: Total magnetic intensity (TMI) map

2.2 Methodology

The potential field data were emptied into the World Geodetic System 84 (WGS 84) and Universal Transverse Mercator coordinate system at zone 32 of Northern hemisphere (UTM 32N) in Oasis Montaj programe. The data directories were hosted in the 3D Euler deconvolution tools, which created control files that were employed in the different enhancement and modeling procedures.

2.2.1 Euler Deconvolution

This technique is used to estimate the depth and geometry of magnetic sources such as faults, dykes, and sills. Euler deconvolution in one form or another has seen its application to gravity or magnetic data in Geophysics for quite some time. It is based on Euler's homogeneity equation (Hood, 1965), which relates the spatial derivatives of the observed magnetic field to the location of the magnetic source. The equation of homogeneity was specifically developed for magnetic data analysis. The application of the conventional Euler's de-convolution to both gravity data and magnetic gradients has been applied previously. However, most of these applications either used magnetic gradients derived from vertical components in the measured magnetic or were based on model simulation data (Zhang, et al., 2000). Researcher studied and applied Euler de-convolution technique to potential field data and found out that the technique is helpful in speedy interpretation of potential field data in terms of geological structures and depth (Thompson, 1982). Euler de-convolution aids the interpretation of gravity field and involves the determination of the location of the body causing anomaly based on analysis of gravity gradients, pulse gravity fields and some constraints on the body geometry (Odek et al., 2012).

The structural index N plays a crucial role, as it characterizes the source's geometry. For example, N=0 represents a contact or fault, N=1 represents a dyke, and N=2 represents a sphere or pipe (Thompson, 1982; Ekpo et al., 2024b). The following is a review of Euler's basic de-convolution concepts and also derivation of Euler's de-convolution tensor for gravity tensor gradient. The technique applies Euler equation of homogeneity.

$$(x - x_0)Tzy + (y - y_0)Tzy + (z - z_0)Tzz = N(Bz - Tz) \qquad (1)$$

If we consider the vertical component of the magnetic and or gravity anomaly of a body, Tz with a homogeneous field, then the co-ordinates x_0, y_0 and z_0 are the source body's unknown coordinates whose edges or center is being estimated and x, y, and z are the known coordinates of the potential field and gradients of the observation point. The three value T_{zx}, T_{zy}, T_{zz} are therefore the magnetic and or gravity gradients $\frac{\partial T}{\partial x}, \frac{\partial T}{\partial y}$ *and* $\frac{\partial T}{\partial z}$ measured along directions x, y and z. N is thus the structural index and B_z is the regional potential field value being estimated. Rewriting Equation (1), we get:

$$\mathrm{xTzx + yTzy + zTzz + NTz} = x_0\mathrm{Tzx} + y_0\mathrm{Tzy} + z_0\mathrm{Tzz + NBz} \qquad (2)$$

In equation (2), there are four parameters that are unknown; x_0, $y_{0,}$ z_0 and B_z within a selected window of n number of data points available for solving the four unknown parameters. If n is greater than 4, these parameters can be estimated using other techniques such as Moore-Penrose inversion (Lawson and Hanson, 1974). Euler deconvolution will be applied in this study to estimate the depth of fault systems and volcanic intrusions. These features are important for understanding the region's tectonic history and assessing the potential for hydrocarbon reservoirs. By applying this method across a grid of the potential field data, a 3D map of subsurface magnetic and or gravity sources can be generated, providing insights into the geological structures at various depths (Reid et al., 1990).

The 3-D Euler deconvolution technique was applied to the TMI data in order to detect the locations and depth values of the different lineaments and faults in the study area as well as map the structural extent of the geologic body. The system uses a least squares method to solve Euler's equation simultaneously for each grid position within a window and then determines the anomaly position, depth, and base level for a specific gravity source. The obtained Euler deconvolution solution was applied to the TMI anomaly map with a specific structure indexes (SI) of 1, which indicates the presence of dyke, sill, step, and ribbon was used. Maximum depth tolerance of 15 with a window size of 20 was applied. Maximum acceptable distance of 3500m which is half the search window and a flying height of 80m was used in the analysis. It is obvious that, the depth for the Euler deconvolution of the TMI data of the study area ranges from minimum depth value of less than 112 m to maximum depth value of more than 2,061 m, and the subsurface lineaments and fault structures are oriented in different directions such as NNW-SSE, NE-SW and E-W taking the trends of the prevailing lineament structure of the Niger Delta. The white portion in the map are the areas where the structural index cannot be reliably estimated due to small local wave number. In these portions, the model independent local wave number had been set to zero.

3. PYRITE OCCURRENCE IN THE AKATA FORMATION AND ITS IMPLICATIONS IN MAGNETIC EXPLORATION

Pyrite, a common sulfide mineral, has been identified in the shale formations of the Niger Delta, particularly within the Akata Formation. These shales, which are rich in organic material, often contain pyrite due to the reducing conditions during sediment deposition. The formation of pyrite is typically associated with early diagenetic processes in organic-rich environments, where sulfate-reducing bacteria convert sulfur compounds into sulfide, which then reacts with iron to form pyrite. In the Niger Delta, the presence of pyrite in the shales is significant because it can influence the magnetic properties of the subsurface, impacting geophysical exploration methods such as magnetic surveys. Pyrite's occurrence is also indicative of anoxic depositional environments, which are favorable for the preservation of organic matter, making these shales important source rocks for hydrocarbon generation (Tuttle et al., 2015). Studies have shown that the Akata shales, with their pyritic content, play a crucial role in the basin's hydrocarbon system as they provide both the source material and the conditions necessary for the generation and migration of hydrocarbons (Doust and Omatsola, 1990).

4. ANALYSIS OF KEY GEOLOGICAL FEATURES

The Euler Deconvolution Map (Figure 5) for the northwestern and eastern high elevation zones, between latitudes 5°10'–5°50'N and longitudes 7°20'–7°50'E and 8°20'–8°50'E, displays numerous shallow depth anomalies ranging between 0.5 and 2 Km. These clusters of solutions suggest the presence of near-surface fault systems, likely associated with high-angle normal faults resulting from extensional tectonics. The dominant orientation of these faults is northwest-southeast and northeast-southwest, reflecting the primary stress regime in the Niger Delta Basin. These fault systems may play a dual role as both migration pathways and traps for hydrocarbons, particularly in the Agbada Formation, known for its sand-shale intercalations that provide suitable conditions for reservoirs and seals.

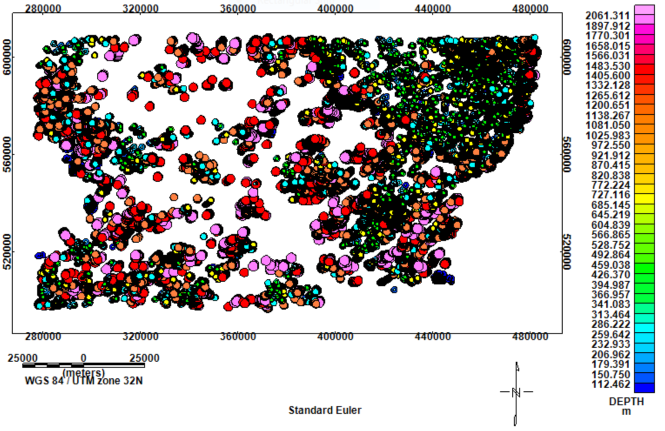


Figure 5: Euler Deconvolution map

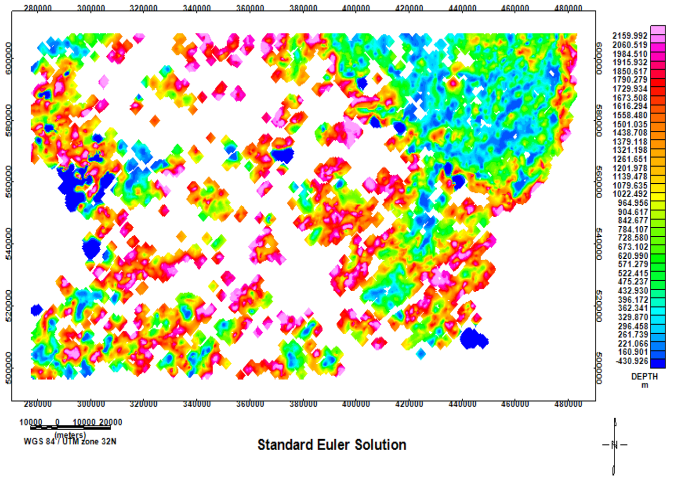


Figure 6: Standard Euler solution map

In contrast, the central basin zone, situated between latitudes 4°50'–5°10'N and longitudes 7°40'–8°20'E, shows fewer Euler solutions (Figure 6) distributed at depths ranging from 2 to 5 Km. This pattern corresponds with the transitional zone between the shallow continental shelf and the deeper basin environments. The relatively sparse distribution of solutions indicates a deeper basement with minimal influence from near-surface faulting. However, isolated clusters of deeper solutions could point to subsurface structures such as buried faults or fold closures, which may serve as hydrocarbon traps (Reijers and Nwajide, 1997). The central basin zone represents a more stable part of the Niger Delta Basin with deeper sediment deposits and fewer surface disruptions, making it potentially favorable for deep-seated hydrocarbon accumulations, especially within the deeper layers of the Akata Formation (Tuttle et al., 2015).

Further south, in the lowland zone between latitudes 4°50'–5°00'N and longitudes 7°00'–7°40'E, the Euler Deconvolution Map shows even fewer solutions, with depth estimates ranging from 3 to 7 Km. These deeper anomalies suggest magnetic sources located at greater depths. This region corresponds to the southern lowlands of the basin, where the thickness of sedimentary layers increases. The depth solutions here indicate the presence of deeper faults or basement structures, which could be related to the extension and subsidence of the deltaic region. These faults may link deeper sedimentary sequences to basement rocks, potentially influencing fluid migration. The deeper anomalies could represent buried structural highs or faulted blocks, which might act as deeper hydrocarbon traps, particularly in the Akata Formation, known for its shale diapirism (Doust and Omatsola, 1990).

The identification of shale diapirs, which are geological structures formed by the upward intrusion of over-pressured ductile shale layers, is critical in understanding the subsurface geology of the Niger Delta. These structures are typically formed when shales from formations like the Akata Formation rise through overlying, more brittle sedimentary layers due to buoyancy (Ekweozor and Daukoru, 1994). On the Euler Deconvolution maps, shale diapirs manifest as magnetic anomalies characterized by dome-shaped clusters of solutions, often indicating upward movement or intrusion (Li and Oldenburg, 1996, Thurston et al., 1999). The map reveals significant clusters of depth solutions ranging from 1.5 to 3 Km in the western parts of the study area, specifically between latitudes 5°00'–5°30'N and longitudes 7°30'–8°00'E. These clusters align with the known depths of the Akata Formation in this region, supporting the interpretation of diapiric activity. The circular or elliptical clustering patterns further reinforce the presence of these structures, which are capable of creating structural traps for hydrocarbons by deforming overlying formations, forming traps where hydrocarbons may accumulate (Tuttle et al., 2015). The proximity of these shale diapirs to known hydrocarbon-bearing zones enhances their exploration potential (Lehner and de Ruiter, 1977).

In addition to shale diapirs, the Euler Deconvolution maps reveal several fault and fracture zones, which are key to understanding the region's subsurface structure. Faults and fractures often display distinct magnetic or gravity signatures that can be detected and analyzed using Euler Deconvolution techniques. On the maps, faults typically appear as linear alignments of depth solutions due to their elongated nature. In the Niger Delta, prominent linear clusters of solutions are evident in the northwestern and eastern parts of the study area, located between latitudes 5°10'–5°50'N and longitudes 7°20'–7°50'E and 8°20'–8°50'E. These clusters exhibit northwest-southeast and northeast-southwest orientations, consistent with the regional tectonic patterns (Weber & Daukoru, 1975). Fault zones also show variations in depth solutions, ranging from shallow depths of 1 to 2 Km to deeper levels of up to 4 or 5 Km, indicating significant vertical displacement along fault planes (Short and Stauble, 1967). Additionally, areas where Euler solutions converge or diverge may indicate fault intersections or zones where faults branch or terminate. These faults are essential for hydrocarbon exploration as they provide pathways for fluid migration and can create structural traps when they juxtapose permeable and impermeable layers (Evamy et al., 1978).

The Euler Deconvolution maps also highlight several potential hydrocarbon zones where geological conditions are conducive to the accumulation and trapping of hydrocarbons. These zones are often associated with specific structural features, such as structural closures and fault-bounded traps (Merki, 1972). Structural closures, like anticlines or fault-bounded traps, are common sites for hydrocarbon accumulation and are characterized by clusters of Euler solutions that converge, indicating a local high in the subsurface where porous reservoir rocks are trapped beneath impermeable seals. The Niger Delta's extensional tectonics have generated numerous growth faults and rollover anticlines, which can serve as effective traps for hydrocarbons (Doust and Omatsola, 1990). Such traps are indicated by linear solutions that show abrupt depth changes across fault zones (Corredor et al., 2005).

The maps suggest several specific zones with high hydrocarbon potential. In the northwestern zone, concentrated clusters of depth solutions form dome-like patterns, suggesting the presence of a rollover anticline, a common trap type in the Niger Delta where hydrocarbons accumulate updip of a growth fault (Weber and Daukoru, 1975). In the eastern region, dense clusters of Euler solutions between 1 and 4 Km depth form elongated, crescent-shaped patterns indicative of fault-bounded structural traps with multiple closures formed by intersecting faults. In the central basin zone, isolated clusters of solutions at depths of 2 to 5 Km align with known rollover anticlines and structural closures associated with growth faults, indicating potential hydrocarbon zones (Evamy et al., 1978). Lastly, in the western shale diapir zones, clusters of Euler solutions form distinctive dome-like patterns with depths ranging from 1.5 to 3 Km, indicating the presence of shale diapirs where over-pressured shale from the Akata Formation has intruded into overlying formations. The upward movement of these shales forms traps in the overlying sand-rich Agbada Formation by deforming the strata above, making these zones highly prospective for hydrocarbon exploration.

5. CONCLUSION

In conclusion, the Euler Deconvolution and Standard Euler Deconvolution maps provide valuable insights into the subsurface geology of the Niger Delta Basin. They identify critical features such as shale diapirs, faulting, fracture zones, and potential hydrocarbon traps that are crucial for guiding exploration strategies in the region. The maps suggest that targeted exploration in areas with high hydrocarbon potential, such as fault zones, shale diapirs, and structural closures, could lead to significant hydrocarbon discoveries. By focusing on these features, the maps help pinpoint areas with high exploration potential, enhance the understanding of the complex geological framework of the Niger Delta, and improve the success rate of hydrocarbon exploration in this prolific basin.

SPECIFIC RECOMMENDATIONS

- Target Shale Diapirs in Akwa Ibom State for Hydrocarbon Exploration:

Rationale: The presence of significant shale diapirs in the western part of Akwa Ibom State (between latitudes 5°00'–5°30'N and longitudes 7°30'–8°00'E) is evident from the Euler Deconvolution maps, which show dome-shaped clusters of solutions at depths of 1.5 to 3 km. These diapirs, formed by the upward movement of over-pressured shales from the Akata Formation, create structural traps by deforming overlying formations such as the sand-rich Agbada Formation.

Recommendation: Prioritize detailed seismic surveys and drilling in these identified zones to confirm the extent and continuity of the shale diapirs. Focus on exploring areas around the identified diapirs where deformation may create effective hydrocarbon traps.

- Explore Fault and Fracture Zones in Imo, Rivers, and Cross River States:

Rationale: The Euler Deconvolution maps highlight prominent linear clusters of solutions in the northwestern and eastern parts of the study area, particularly in Imo, Rivers, and Cross River States (latitudes 5°10'–5°50'N and longitudes 7°20'–7°50'E and 8°20'–8°50'E). These clusters indicate the presence of major fault systems trending NW-SE and NE-SW, with depth solutions ranging from 1 to 5 km. These faults could provide migration pathways for hydrocarbons or create fault-bounded traps.

Recommendation: Conduct targeted seismic imaging and subsurface mapping along these fault zones to assess their potential for hydrocarbon migration and accumulation. Pay special attention to fault intersections and zones where faults branch or terminate, as these locations may serve as highly effective traps.

- Focus on Potential Hydrocarbon Zones in the Central Basin and Lowland Zones:

Rationale: The central basin zone (latitudes 4°50'–5°10'N and longitudes 7°40'–8°20'E) and the southern lowland zone (latitudes 4°50'–5°00'N and longitudes 7°00'–7°40'E) show fewer but deeper Euler solutions, suggesting deeper-seated hydrocarbon traps. The central basin is characterized by stable geological conditions and deeper sedimentary deposits, making it favorable for deep-seated accumulations within the Akata Formation. The southern lowland zone shows anomalies at depths of 3 to 7 km, indicating potential deeper faulted blocks or buried structural highs.

Recommendation: Conduct deep drilling and geophysical surveys to explore these deeper targets. Focus on identifying subsurface structures such as buried faults, fold closures, and potential structural highs that could serve as traps for deep-seated hydrocarbons, particularly in the Akata Formation.

- Leverage Euler Deconvolution Techniques to Refine Structural Mapping:

Rationale: The use of Euler Deconvolution and Standard Euler Deconvolution maps has proven effective in identifying key structural features like faults, fractures, and shale diapirs. These techniques can quickly and cost-effectively provide an initial interpretation of the subsurface geological framework.

Recommendation: Continue applying and refining Euler Deconvolution techniques in combination with other geophysical methods, such as seismic and gravity surveys, to improve the resolution and accuracy of subsurface structural mapping. Utilize these combined approaches to identify new exploration targets and minimize the risk of drilling dry wells.

- Integrate Multidisciplinary Data for Improved Exploration Strategy:

Rationale: The success of hydrocarbon exploration in complex geological settings like the Niger Delta relies on integrating multiple datasets to create a comprehensive subsurface model. The findings from Euler Deconvolution maps should be corroborated with seismic data, well logs, and geological field studies to enhance confidence in target selection.

Recommendation: Develop an integrated exploration strategy that combines Euler Deconvolution results with seismic data, geological mapping, petrophysical analyses, and reservoir modeling. This integrated approach will help in better understanding the spatial distribution, geometry, and depth of hydrocarbon traps, leading to more successful exploration outcomes.

- Focus Exploration Efforts on High-Potential Areas Identified by Both Maps:

Rationale: Areas where both the Euler Deconvolution and Standard Euler Deconvolution maps show high concentrations of solutions, such as the northwestern and eastern regions, should be prioritized. These areas exhibit features like rollover anticlines, fault-bounded traps, and diapir-induced traps, which are likely to contain significant hydrocarbon reserves.

Recommendation: Prioritize these high-potential areas for immediate exploration activities, including more detailed geophysical surveys, seismic interpretation, and exploratory drilling. Special attention should be given to structures that align with known productive formations like the Agbada and Akata Formations.

REFERENCES

Corredor, F., Shaw, J. H., and Bilotti, F., 2005. Structural styles in the deep-water fold and thrust belts of the Niger Delta. AAPG Bulletin, 89(6), Pp. 753-780.

Doust, H., and Omatsola, E., 1990. Niger Delta. In J. D. Edwards and P. A. Santogrossi (Eds.), Divergent/passive margin basins, 48, Pp. 201-238. AAPG.

Ekpo A. E., Bassey, N. E., George N. J., 2024. Aero-gravity data analysis for delineating possible channels of mineralizations migration through lineament. A case study of Southeastern Niger Delta, Nigeria. AKSU Annels of Sustainable Development 2(1), Pp. 139-168. https://doi.org/10.60787/AASD-v2i1-35.

Ekpo, A. E., Bassey, N. E., George, N. J., and Udo, I. G., 2024. Depth to basement estimation from aerogravity data over the Southeastern part of Niger Delta region of Nigeria. Researchers Journal of Science and Technology, 4(5), Pp. 44–66. Retrieved from https://rejost.com.ng/index.php/home/article/view/135

Ekweozor, C. M., and Daukoru, E. M., 1994. Northern delta depobelt portion of the Akata-Agbada(!) petroleum system, Niger Delta, Nigeria. Chapter 35 - The Petroleum System—From Source to Trap, AAPG Memoir 60.

Evamy, B. D., Haremboure, J., Kamerling, P., Knaap, W. A., Molloy, F. A., and Rowlands, P. H., 1978. Hydrocarbon habitat of the Tertiary Niger Delta. AAPG Bulletin, 62(1), Pp. 1-39.

Hood, P. J. and Teskey, D. J., 1989. Aeromagnetic gradiometer program of the geological survey of Canada. Geophysics, 54(8), Pp. 1012-1022.

Lawson, C.L., Hanson, R.J., 1974. Solving Least Squares Problems. Prentice-Hall, Englewood Cliffs.

Lehner, P., and de Ruiter, P. A. C., 1977. Structural history of Atlantic margin of Africa. AAPG Bulletin, 61(7), Pp. 961-981.

Li, Y., and Oldenburg, D. W., 1996. 3D inversion of magnetic data. Geophysics, 61(2), Pp. 394-408. https://doi.org/10.1190/1.1443968

Merki, P. J., 1972. Structural geology of the Cenozoic Niger Delta. African Geology, University of Ibadan Press.

Nabighian, M. N., Ander, M. E., Grauch, V. J. S., Hansen, R. O., LaFehr, T. R., Li, Y., Peirce, J. W., Phillips, J. D., and Ruder, M. E., 2005. The historical development of the magnetic method in exploration. Geophysics, 70(6), Pp. 33ND-61ND.

Odek, A., Otieno, A. B., Ambusso, W. J. and Githiri, J. G., 2012. 2d-Euler deconvolution and forward modeling of gravity data of homa-hills geothermal prospect, kenya. Journal of Agriculture, Science and Technology, 15(1)

Reijers, T. J. A., and Nwajide, C. S., 1997. Geology of the southern Anambra Basin. In Selected Chapters on Geology: Geology of Nigeria.

Short, K. C., and Stauble, A. J., 1967. Outline of the geology of the Niger Delta. **AAPG

Thompson, D.T., 1982. EULDPH-A New Technique for Making Computer Estimates from Magnetic Data. Geophysics, 47, Pp. 31-37.

Thurston, J. B. and Smith, R. S., 1997. Automatic conversion of magnetic data to depth, dip, and susceptibility contrast using SPITM method. Geophysics, 62, Pp. 807-813.

Thurston, J. B., Smith, R. S., and Guo, W. 1999. Automatic conversion of magnetic data to depth, dip, and susceptibility contrast using the SPI™ method. Geophysics, 64(3), Pp. 807-813.

Thurston, J. B., Smith, R. S., and Guo, W., 1999. Automatic conversion of magnetic data to depth, dip, and susceptibility contrast using the SPI™ method. Geophysics, 64(1), Pp. 64-75. https://doi.org/10.1190/1.1444530

Tuttle, M., Charpentier, R., and Brownfield, M., 2015. "The Niger Delta Petroleum System: Niger Delta Province, Nigeria, Cameroon, and Equatorial Guinea, Africa". United States Geologic Survey. United States Geologic Survey. Retrieved 6 March 2015.

Zhang C, Mushayandebvu, M. F., Reid A. B., Fairhead J. D. and Odegard M. E., 2000. Euler De-convolution of Gravity Tensor Gradient Data. Geophysics, 65, Pp. 512-520.

Cite The Article: Aniekan E. Ekpo, Nsikak E. Bassey, Nyakno J George, Itoro C. Udo (2024). Application of Euler Deconvolution Techniques for Identifying Hydrocarbon Traps in the Southeastern Niger Delta Basin Using Aeromagnetic Data. *Pakistan Journal of Geology, 8(1): 74-79.*