*FUDMA Journal of Sciences (FJS)*
*ISSN online: 2616-1370*
*ISSN print: 2645 - 2944*
*Vol. 10 No. 12, June, 2026, pp 235 – 241*
*DOI:* https://doi.org/10.33003/fjs-2026-1012-5663

# Integrated Aeromagnetic and Aero-radiometric Data for delineating Lithologies, Structures and Hydrothermal Alteration Zones in Ganmo–Amoyo–Ojoku Areas, Nigeria

**[1]Jimoh Ajadi, *[2]Folorunso Owolabi Wahab, [1]Gabriel Efomeh Omolaiye, [3]Yusuf Magaji and [4]Mudashir Olayiwola Raheem**

[1]Department of Geology and Mineral Science, Kwara State University Malete, Kwara State, Nigeria.
[2]Geological Technology Department, Federal Polytechnic Offa, Kwara State, Nigeria.
[3]Department of Geophysics, University of Ilorin, Ilorin, Kwara State, Nigeria.
[4]Department of Geology, Bayero University, Kano State, Nigeria.

*Corresponding authors' email: owolabi.folorunsho@fedpoffaonline.edu.ng

**ABSTRACT**

Aeromagnetic and aero-radiometric methods have been successfully used to locate zones of mineralization potentials in Ganmo–Amoyo–Ojoku areas by mapping lithology, structures and hydrothermal alteration regions for industrial purposes. The data, sheet 223-Ilorin on a scale of 1:100,000 were obtained from the Nigerian Geological Survey Agency (NGSA) at a height of 80 meters along a series of NE-SW flight lines spaced 500 m interval. The Total Magnetic Intensity data was gridded at 100 m then reduction to the magnetic equator (RTE) was applied to center magnetic anomalies over their respective magnetic source bodies with the aid of Oasis Montaj™ software. Other enhancement techniques applied are first vertical derivative (FVD), analytic signal (AS) and tilt angular derivative (TDR). In addition, the potassium to equivalent thorium (K/eTh) ratio and ternary radiometric maps were revealed to support the delineation process. The interpreted map for magnetic lineaments by delineating the anomaly maxima mostly observed in the southern and eastern portions of the study area extending from Orogun to Apala and Alaya with continuous linear contour patterns. The lineaments range in lengths from 50 m to 1000 m while the orientations range from NE-SW to NW-SE. The equivalent ratio of potassium-thorium and ternary map revealed lithological units and hydrothermal alterations within the basement complex. From this study, volcanic intrusions, lineament structures, and hydrothermal alteration zones were delineated. These intrusions resulted from the high content of magnetic anomalies related to the mineralized potential zones in the area. The integration of both magnetic and radiometric maps has revealed an approximate understanding between radiation zones, observed fractures, and faults in the locations between the boundaries of rock types in the study area.

**Received:** 19th July 2026

**Accepted:** 23rd July 2026

**Published:** 31st July 2026

**Keywords:** Aeromagnetic data, radiometric data, structural lineaments, Oasis Montaj, hydrothermal alteration

## INTRODUCTION

Many authors emphasized the importance of lineament mapping as part of various geological investigations (e.g. Mwaniki *et al.*, 2015; Ramli *et al.*, 2010; Magaji & Sanusi, 2021). Lineament extraction can help interpret the regional structure of a given area and discern its different structural elements (Magaji and Sanusi, 2021; Abdelouhed *et al.*, 2022; Bentahar *et al.*, 2020; Fossi *et al.*, 2021). Lineaments can also assist in understanding underlying rocks architecture (e.g. basement faults), exploring mineral deposits (Magaji *et al.*, 2025a; Adepoju *et al.*, 2021; Hubbard *et al.*, 2012; Liu *et al.*, 2000), and discovering groundwater reservoirs (Al-Saedi, 2013; Bruning *et al.*, 2011; Saint Jean Patrick Coulibaly *et al.*, 2020; Adhab, 2014; Soliman & Han, 2019). The description given by Benabbas (2006) was retained, defining the lineaments as rectilinear or slightly curved structures that appear in landscape and which may correspond either to physiographic features linked to vegetation, hydrography, or morphology: ridges, relief limits, outcrop lines, or to elements of structural origin: faults, reversals of layers, a dense network of joints.

In digital image processing, lineaments usually occur as edges with tonal differences. Most extraction techniques are based on edge enhancement by improving the tone, the hue, and the image structure (Magaji *et al*., 2025b; Folorunso *et al*., 2024; Hung *et al*., 2005; Javhar *et al*., 2019). In this regard, two methods are proposed for identifying and extracting lineaments from remote sensing data: manual and automatic. The manual method consists of enhancing the tonal differences, then visually interpreting the lineament segments of the satellite image. This technique is efficient but it is relatively time-consuming and more importantly highly subjective. The automatic method uses computer software and algorithms to detect and extract lineaments automatically. Although this technique is quick, it generates many insignificant lineaments and must go through a post-processing phase that includes validation and removing anthropic lineaments. As a result, some manual processing should be incorporated (Abdelouhed *et al*., 2022). However, Ahmadi and Pekkan (2021) proposed that a single method may not provide an accurate lineament distribution. It is therefore necessary that the identification and extraction of lineaments integrate different methods.

This study thereby combines magnetic and radiometric methods to detect and extract lineaments which reflect deep geological structures such as basement faults, folds, joints etc.

Magnetic method is used in the investigation of the subsurface geology of an area. This is achieved by detecting magnetic anomalies within the earth's magnetic field which are normally caused by magnetic susceptibility changes of the underlying rocks. Most rock forming minerals are non-magnetic but a few that contain sufficient amount of magnetic grains in them can impact magnetism to their host rock thus, producing detectable magnetic anomalies. The application of radiometric method is useful in geologic mapping because of its ability to detect radioactivity emanating from the natural decay of elements such as uranium, thorium and potassium from the earth material. The product of this decay results in the emission of alpha, beta and gamma radiations which can be detected on the surface using radioactive element detectors.

Magnetic and radiometric data have been conjunctively used in the study of lithologies and structures in Yola area, Nigeria (Bassey and Ishaku, 2012), in Ashanti gold belt of Ghana (Boadi *et al.,* 2013). Radiometric exploration for uranium in N.E. Nigeria has been done by several researchers (Okujeni, 1987; Okujeni *et al.*, 1987; Mustapha 1992; Su and Dada, 1998; Haruna *et al.*, 2011). The present work jointly analyze data from aeromagnetic and ground radiometric sources over Ganmo–Amoyo–Ojoku areas. Hence information from both aeromagnetic and ground radiometric data can be well correlated with ground information. The objectives of this work are to identify structural features, lithologies, magnetic source and hydrothermal alteration zones from images of the area.

**Geographic Location and Geological Settings of the Study Area**

The study area (Figure 1) is located within Ilorin Sheet 223 NW in southwestern Nigeria and forms part of the Nigerian Basement Complex, a segment of the Pan-African mobile belt. This basement terrain is composed predominantly of high-grade metamorphic rocks and granitoids that have undergone multiple phases of deformation, metamorphism, and magmatism during the Pan-African orogeny. Regionally, the Nigerian Basement Complex is subdivided into the migmatite–gneiss complex, the schist belts and the Pan-African granitoids. The migmatite–gneiss complex constitutes the oldest component and comprises banded gneisses, migmatites, and associated granitoid intrusions (Ajibade *et al.,* 1987; Dada, 1998; Turner, 1983).

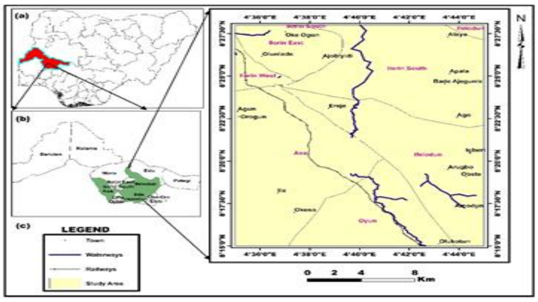

Figure 1: Location map of the study area

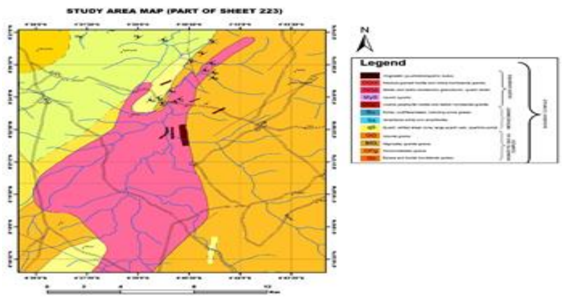

Figure 2: Geological map of the study area

The Pan-African granitoids, often referred to as Older Granites, are widely distributed and range in composition from dioritic to granitic (Rahaman, 1989). These rocks are commonly associated with late-stage pegmatitic and aplite intrusions, reflecting the final stages of magmatic evolution. Within the Ganmo–Amoyo–Ojoku geological map (Figure 2), the principal lithologies include biotite gneiss, augen gneiss, charnockitic rocks, porphyritic diorites, and granitoids, with pegmatite and aplite occurring as cross-cutting bodies. Field relationships suggest that the gneissic rocks form the basement framework into which younger intrusive bodies were emplaced. Pegmatitic veins commonly cut across earlier lithologies, indicating emplacement during the late stages of magmatic activity. Overall, the geological setting reflects a structurally complex basement terrain in which lithological diversity and deformation patterns are closely linked (Rahaman, 1988). This context is essential for understanding the geophysical signatures observed in the study area and for developing an integrated interpretation of subsurface architecture.

## MATERIALS AND METHODS

**Data Acquisition**

The aeromagnetic and aero-radiometric data used for this work is sheet number 223 bounded between longitudes $004^0$ 00' E to $004^0$ 30' E and latitudes $08^0$ 30' N to $09^0$ 00' N. on a scale of 1:100,000. The data were acquired as part of a second nationwide aeromagnetic survey conducted in two phases by Fugro Airborne Surveys from 2005 to 2010 on behalf of the Federal Government of Nigeria (FGN). The data were acquired (i) along a series of NW – SE flight lines at an interval of 500 m, and a tie line spacing of 2000 m along NE-SW direction, (ii) at an average of 80 m terrain clearance, and (iii) data recording interval of 0.1 s (~7 m). The new data has an added advantage of high resolution over the data acquired in the first nationwide survey conducted between 1974 – 1976, which were obtained using a flight elevation of 150 m and flight line spacing of 2000 m.

**Data Processing**

Reduction to the equator (RTE) correction was performed on the aeromagnetic anomaly data (Figure 3) because of the variation in inclination and declination of the geomagnetic field from the geomagnetic equator to the pole, such that the peaks of total magnetic anomalies due to subsurface are shifted from directly over the source and the anomalies becomes highly asymmetric. Byapplying this correction, the spatial shift in the shape and the peak of the magnetic anomalies over their causative sources are corrected (Hinze *et al.,* 2013). Thus, a RTE correction of 4.132° declination, 9.5342° inclination, a grid cell size of 100 m, and a minimum curvature gridding was applied for this area using the Oasis Montaj (R) software, version 8 (Phillips, 2007; Lawal and Nwankwo, 2017). For the radiometric data, potassium (K), thorium (Th), and uranium (U) were procured in grid form and processed using the Oasis Montaj (R) software, version 8.

**First Vertical Derivative (FVD)**
The FVD is used to enhance shallow features with their boundaries and associated lineaments (Eldosouky *et al.*, 2017). This technique has the ability of amplifying high–wave number anomalous features at the expense of the lower ones (Ibraheem *et al.*, 2019). As a result, shallow features can be properly identified and mapped (Nabighian 1972). Evjen (1936) was the first to delineate edges of gravity and magnetic bodies using the first vertical derivative. If M is the magnetic field, the expression for the FVD is given as (Ibraheem *et al.*, 2019).

$$\mathrm{FVD} = \frac{\partial \mathrm{M}}{\partial \mathrm{x}} \qquad (1)$$

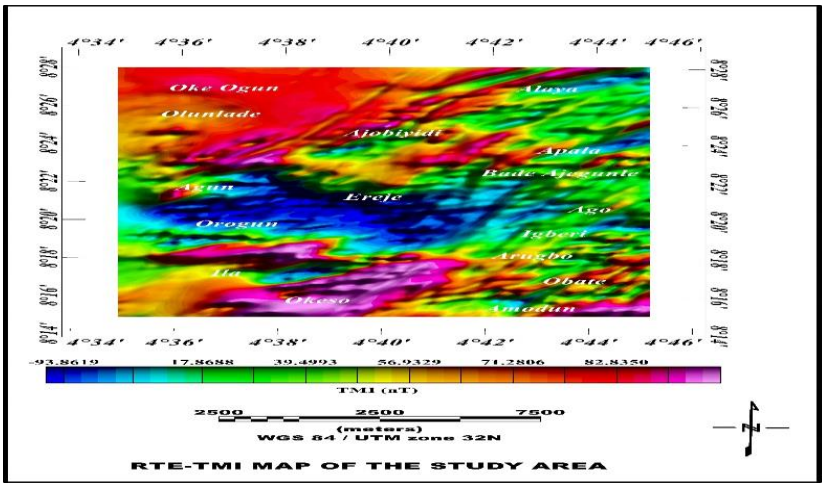


Figure 3: RTE-TMI map of the study area

**Analytic signal (AS)**
Analytic signal is an enhanced technique which is related to potential fields (e.g., magnetic field data) by obtaining their derivatives. The expression is given as follows (Nabighian 1972):

$$\mathrm{AS}\ (x,y,z) = \sqrt{(\partial M/\partial x)^2{}_{\hat{x}} + (\partial M/\partial y)^2{}_{\hat{y}} + (\partial M/\partial z)^2{}_{\hat{z}}} \qquad (2)$$

Where $\hat{x}$, $\hat{y}$ and $\hat{z}$ are the unit vectors in *x*, *y*, and *z* directions

**Tilt Angle Derivative (TDR)**
The tilt derivative filter has been demonstrated by Verduzco *et al.*, (2004) to carry out an automatic gain-control (AGC) function, which attempts to balance the response from both strong and weak anomalies. As a result, the filter offers a useful method for locating notable anomalies within the study region. The TDR was performed on the Residual Magnetic Anomaly (RMA) maps. According to Miller and Singh (1994), the tilt angle is defined as:

$$\theta = \mathrm{TDR} = \tan^{-1}\frac{(\mathrm{FVD}_{(z)})}{(\mathrm{HGM}_{(x,y)})} \qquad (3)$$

Where $\mathrm{FVD}_{(z)}$ = First Vertical Derivative and $\mathrm{HGM}_{(x,y)}$ = Total Horizontal Gradient
Although the tilt angle gradient is a dimensionless ratio, it responds well to both deep and shallow sources, as well as sources at the same level with a wide dynamic range of amplitudes (Cooper, 2006). The TDR values are much easier to grasp because they are limited to values between - ð/2 and +ϋ/2 (Cooper, 2006).

**RESULTS AND DISCUSSION**
**First Vertical Derivative map**
The results obtained after applying the FVD filtering method (Figure 4) give a good representation of features closer to the subsurface, e.g., faults (white lines). In this case, the filtration of data enhanced high-frequency anomalies so that shallower sources could be mapped at the expense of the low-frequency ones. Almost all the entire area is occupied by these high-frequency anomalies, indicating shallow depth to causative sources in comparison with some other parts such as southwest, northeast, northwest and part of north central with deeper sources which have the presence of sedimentary covers (Salem *et al.*, 2007). Also, on the map are long and short linear features distinguishing the edges of magnetic source bodies with zero contour lines representingthe locations of the contacts or faults. The long linear features, which are continuous and less prominently trend in the NE–SW and NW–SE directions, represent lithological boundaries and could be interpreted as major fracture/fault lines on the map, while the short linear and curvilinear features with their orientation trending mostly NW–SE and E–W are also concentrated within the lithological boundaries of magnetic source bodies of migmatite gneiss and biotite gneiss. It is also interesting to note that both long and short linear features are defined by a contour value of zero that coincides with the peaks in both AS map (Figure 5).

**Analytical Signal (AS) map**
The AS map (Figure 5) reveals magnetic anomalies ranging from 0.0065 to 0.2249 nT/km. The map was interpreted for magnetic lineaments by delineating the anomaly maxima mostly observed in the southern and eastern portions of the study area extending from Orogun to Apala and Alaya with continuous linear contour patterns. The lineaments range in lengths from 50 m to 1000 m while the orientations range from NE-SW to NW-SE. In the first magnetic domain, the majority of maxima are trending in the NE–SW direction, while minor maxima are observed to be trending in the NW–SE direction.

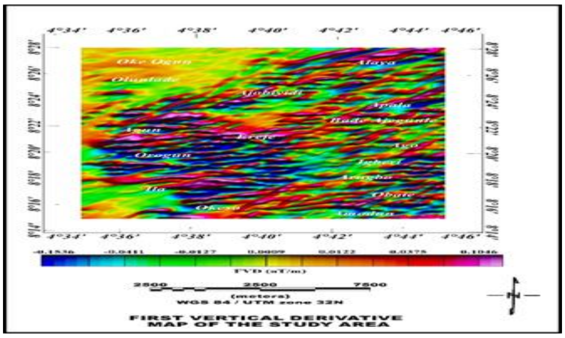


Figure 4: FVD map of the study area

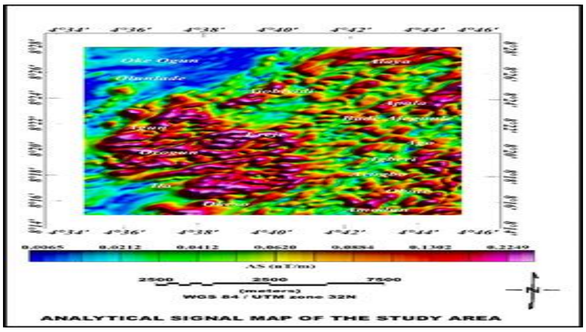


Figure 5: AS map of the study area

These two groups of maxima can be associated with intruded granite bodies (e.g. biotite granite, granite gneiss) rich in ferromagnesian-bearing rocks with a low amount of felsic minerals (Telford *et al*., 1990; Balogun, 2019; Folorunso *et al*., 2024; Magaji *et al.*, 2025). In contrast, the low– and intermediate–magnetic intensity zones might be reflections of downfaulted blocks of the basement complex filled with sediments or possibly a set of tectonic trends controlling the overlying sediments which can be observed at Oke Ogun and Olunlade areas.

**The Tilt Derivative (TDR)**

The TDR filter is normally utilized in the detection and mapping of geologic structures which can be related to shallow basement structural features or mineral exploration targets. The TDR filter was applied to the RTE anomaly data, to provide greater resolution of structural features. The TDR map (Figure 6) demarcates possible edges of geo logic source bodies. The TDR technique facilitates the horizontal location with the extent of edges of magnetic source bodies within the study area. When utilizing the RTE transformation, the TDR is negative (blue and green color) when it is over magnetic source bodies and is positive (red and pink colours) when it is outside the magnetic source bodies. Furthermore, zero-degree tilt angles are also believed to form close to edges of bodies, therefore defining contacts or regions of discontinuities which can also be classified as geologic structures. Consequently, the zero-degree contour lines trend mainly in NE-SW direction.

The composite map (Figure 7) reveals structural complexity within the region under study. Two major structural domains were recognized from the composite map, by changes in inferred lineament patterns, such as spacing and orientation. The southwestern domain which was affected by a major ductile deformation event resulted in E–W trends of what we interpret as faults and folds in the porphyroblastic gnesiss and amphibolite schist, which are probably Eburnean (pre-Pan-African) in age. The eastern domain which was affected by a major ductile–brittle deformation event which resulted in major NE–SW trends in the quartzite rock units. The tectonic activities with the Pan-African compression with the dominant temperature situations could have led to D2 deformations.

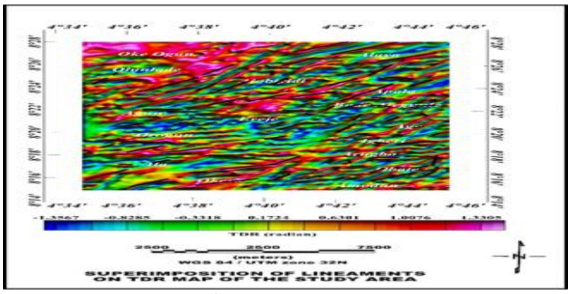


Figure 6: TDR map of the study area

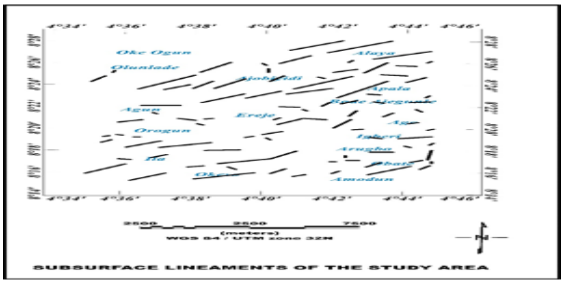


Figure 7: Subsurface Lineaments map

**The K/eTh map**

As high % K and low concentration of eTh are associated with alterations in many ore deposits (Ostrovskiy 1975), the K/eTh ratio map is of great importance for searching signatures associated with hydrothermal alteration zones. This map is depicted in Figure 8. Therein, the areas affected by hydrothermal process are revealed in red to pink color (i.e. 0.2302 to 0.5956 %/ppm) (strong indicator, SI). These SIs are found in the southern, central and northern regions of the study area i.e. Illa, Orogun, Ereje, Ajobiyidi and Oke Ogun though more prominent in the southwest and northeast. These areas are associated with amphibolite, migmatite gneiss, biotite gneiss and porphyritic diorites. On the other hand, the low indicator (LI) observed on the map shows that potassium is low and the thorium concentration is high. As observed on the map, most of these alteration zones are trending towards the NE–SW direction and follow the same pattern with the aeromagnetic data enhancement techniques.

**The ternary map**

Finally, the ternary map (Figure 9) of the study area was generated by modulating the three colours red (R), green (G), and blue (B) in equal proportion so that their intensities could be revealed. From this map, the lithological contrasts resulting from geological and mineral explorations can be interpreted. Here the white colour found in some areas across the study area shows the high level of concentration (HLC) for the radioactive elements which is characterized by strong radiometric response, and these areas can be associated with amphibolite, migmatite gneiss, biotite gneiss. The low concentration of the radioactive elements that represented black (LC) is a resultant of porphyritic diorites. The red colour represents high K content but low Th and U related to granitic body, while the green colour corresponds to regions of high Th, low K and U associated with metamorphic rock formations in the study area.

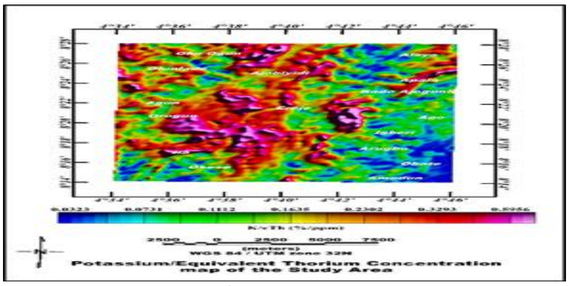

Figure 8: K/eTh map of the study area

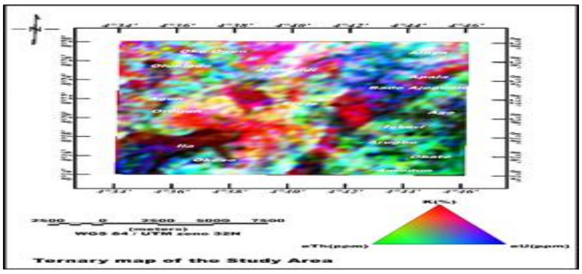

Figure 9: Ternary map of the study area

## CONCLUSION

Aeromagnetic and aero radiometric maps were used to evaluate the spatial relationship between the subsurface structural features, alteration zones, and various lithologies in the zone located in the Ganmo–Amoyo–Ojoku areas of the Migmatite–Gneiss complex units of the southwestern basement complex of Nigeria. The FVD map showed a good representation of features closer to the subsurface by enhancing high-frequency anomalies so that shallower sources could be mapped at the expense of the low-frequency ones. The analytic signal map also showed networks of magnetic discontinuities that might represent fracture zones that could be targets for mineral prospection. The structural features obtained from the magnetic data using various enhancement techniques show that NE, NW, ENE, and NS are the main directions in the area. Evaluation of radiometric data further revealed various lithologies (migmatite gneiss, biotite gneiss, amphibolite, pegmatite and granite diorite) and hydrothermal alteration zones trending in the NE, NW, ENE, and NS directions. Integration of both aeromagnetic and aero radiometric data has further helped in detecting areas where mineral resources can be explored.

## REFERENCES


Abdelouhed, F., Ahmed, A., Abdellah, A., Mohammed, I. & Zouhair, O. (2022). Extraction and analysis of geological lineaments by combining ASTER-GDEM and Landsat-8 image data in the central High Atlas of Morocco. Natural Hazards, 111(2), 1907-1929. https://doi.org/10.1007/s11069 021-05122-9.

Adepoju, M. O., Odeyemi, I. B. & Akinluyi, F. O. (2021). Landsat-8 lineament analysis for detection of epigenetic mineralization zones in parts of Igarra Schist Belt, Southwestern Nigeria. Remote Sensing in Earth Systems Sciences, 4(1), 76-86. https://doi.org/10.1007/s41976-021-00046-1.

Adhab, S. S. (2014). Lineament automatic extraction analysis for Galal Badra river basin using Landsat 8 satellite image. Iraqi Journal of Physics, 12(25), 44-55. https://doi.org/10.30723/ijp.v12i25.303

Ajibade, A. C., Woakes, M., & Rahaman, M. (1987). Proterozoic crustal development in the Pan-African regime of Nigeria. In A. Kroner (Ed.), Proterozoic lithospheric evolution (pp. 259–271). American Geophysical Union.

Al-Saedi, Z. J. (2013). Lineament extraction for assessment of groundwater potential/West of Iraq. Euphrates Journal of Agriculture Science, 5(1), 54-63. https://doi.org/10.13140/RG.2.2.24225.5360 7.

Ahmadi, H. & Pekkan, E. (2021). Fault-based geological lineament extraction using remote sensing and GIS—a review. Geosciences, 11(5), 183. https://doi.org/10.3390/geosciences11050183

Balogun, O. B. (2019). Tectonic and structural analysis of the Migmatite–Gneiss–Quartzite complex of Ilorin area from aeromagnetic data. NRIAG Journal of Astronomy and Geophysics, 8(1), https://doi.org/10.1080/20909977.2019.1615795.

Bassey, N.E. & Ishaku J.M. (2012). Conjunctive use of magnetic and radiometric survey for ferruginous sandstone horizons in Yola Area Nigeria. Journal of Earth Science and Geotechnical Engineering. 6(1):65 70.

Bentahar, I., Raji, M. & Si Mhamdi, H. (2020). Fracture network mapping using Landsat-8 OLI, Sentinel-2A, ASTER, and ASTER GDEM data, in the Rich area (Central High Atlas, Morocco). Arabian Journal of Geosciences, 13(16), 1-19. https://doi.org/10.1007/s12517-020-05736-6

Benabbas, C. (2006). Evolution mio-Plio-Quaternaire des bassins continentaux de l'Algerie nord orientale [Mio-Plio-Quaternary evolution of continental basins of NE Algeria] Université Mentouri-Constantine-]. https://bu.umc.edu.dz/theses/sc terre/BEN4532.pdf

Boadi B, Wemegah D. D. & Preko K. (2013). Geological and structural interpretation of the konongo area of the ashanti gold belt of Ghana from aeromagnetic and radiometric data. International Research Journal of Geology and Mining. (2276-661):3(3):124-135.

Bruning, J. N., Gierke, J. S. & Maclean, A. L. (2011). An approach to lineament analysis for groundwater exploration in Nicaragua. Photogrammetric Engineering and Remote Sensing, 77(5), 509-519. https://doi.org/10.14358/PERS.77.5.509.

Cooper, G.R.J. (2006). Interpreting potential field data using continuous wavelet transforms of their horizontal derivatives. Computer Geosciences 32984–992.

Dada, S. S. (1998). Crust-forming ages and Proterozoic crustal evolution in Nigeria: A reappraisal of current interpretations. Precambrian Research, 87(1), 65–74.

Eldosouky, A.M., Abdelkareem M. & Elkhateeb, S.O. (2017). Integration of remote sensing and aeromagnetic data for mapping structural fea tures and hydrothermal alteration zones in Wadi Allaqi area, South Eastern Desert of Egypt. Journal of Africa Earth Sci. Elsevier 130:28–37.

Evjen, H.M. (1936). The place of the vertical gradient in gravitational interpretations. Geophysics. Society of Exploration Geophysicists 1(1): 127–136.

Folorunsho, I. O., Magaji, Y., Ajadi, J. & Issa, U. (2024). Application of Euler and Werner deconvolution techniques in delineating tin deposit in Okeso area, Southwestern, Nigeria. Proc. Niger. Soc. Phys. Sci. 1(96). https://doi.org/10.61298/pnspsc.2024.1.96.

Fossi, D. H., Dadjo Djomo, H., Takodjou Wambo, J. D., Ganno, S., Pour, A. B., Kankeu, B. & Nzenti, J. P. (2021). Structural lineament mapping in a sub-tropical region using Landsat-8/SRTM data: a case study of Deng-Deng area in Eastern Cameroon. Arabian Journal of Geosciences, 14(23), 1 22. https://doi.org/10.1007/s12517-021 08848-9.

Haruna IV, Valdon YB. & Mamman YD. (2011). Uranium prospecting in an area around Mika, Adamawa Massif, N. E. Nigeria: A Research Note. International Jour. of Environ Sc. 2011; 7(3):105-109.

Hinze W.J., Von-Frese R.R.B., Saad A.H., (2013). Gravity and magnetic exploration: Principles, practices, and applications. Cambridge University Press

Hubbard, B. E., Mack, T. J. &Thompson, A. L. (2012). Lineament analysis of mineral areas of interest in Afghanistan: Automatically delineated lineaments using 30-m TM imagery. U.S. Geological Survey Open-File Report, 1084, 28. http://pubs.usgs.gov/of/2012/1048

Hung, L., Batelaan, O. & de Smedt, F. (2005). Lineament extraction and analysis, comparison of LANDSAT ETM and ASTER imagery. Case study: Suoimuoi tropical karst catchment, Vietnam. Remote Sensing for Environmental Monitoring, GIS Applications, and Geology V, Remote sensing for environmental monitoring, GIS applications, and geology V: 19-20 September 2005, Bruges, Belgium (Proceedings of SPIE - The International Society for Optical Engineering; Vol. 5983). SPIE. https://doi.org/10.1117/12.627699

Ibraheem, I.M., Haggag, M. & Tezkan, B. (2019) Edge detectors as structural imaging tools using aeromagnetic data: a case study of Sohag Area, Egypt. Geosciences. Multidisciplinary Digital Publishing Institute 9(5):211.

Ismaeel, F.O., Yusuf, M., Olarewaju, A.H., Salaudeen, S.A., Obalalu, A.M., Khan, U., Alsawah, G.A. (2025). Muscovite ore exploration using 3-D Euler deconvolution and total horizontal gradient of magnetic anomalies in Eleeku, Northcentral, Nigeria. Z Angew Math Mech. 105, e70247. https://doi.org/10.1002/zamm.7024.

Javhar, A., Chen, X., Bao, A., Jamshed, A., Yunus, M., Jovid, A. & Latipa, T. (2019). Comparison of multi-resolution optical Landsat-8, Sentinel-2 and Radar Sentinel-1 data for automatic lineament extraction: A case study of Alichur area, SE Pamir. Remote Sensing, 11(7), 778. https://doi.org/10.3390/rs11070778

Magaji, Y. and Sanusi, Y. A. (2021). Evaluation of hydrocarbon prospect in Lema area, western parts of Sokoto Basin, Nigeria, based on analysis of high-resolution aeromagnetic data. Quest Journals Journal of Research in Environmental and Earth Sciences, 7(4), 46–61.

Magaji, Y., Folorunso O. I., Salaudeen, A. S., Olajide, A. T. & Wahab, O. F. (2025a). Structural and Mineralization Mapping of Muscovite Ore Deposit in Eleeku Southwestern, Nigeria. FUDMA Journal of Sciences (FJS), 9(10), 277-289.

Magaji, Y., Folorunso O. I., Wahab, O. F. and Salaudeen, A. S. (2025b). Aeromagnetic Perspectives on Basement Morphology and Depth beneath Ilorin Metropolis, Southwestern, Nigeria. Dutse Journal of Pure and Applied Sciences (DUJOPAS), 11(4a), 143-153.

Lawal, T.O. & Nwankwo, L.I. (2017). Evaluation of the depth to the bottom of magnetic sources and heat flow from high resolution aeromagnetic (HRAM) data of part of Nigeria sector of Chad Basin. Arab J Geosci:1–12. https://doi.org/10.1007/s12517-017-3154-2

Liu, C. C., Sousa Jr, M. d. A. & Gopinath, T. R. (2000). Regional structural analysis by remote sensing for mineral exploration, Paraiba State, Northeast Brazil. Geocarto International, 15(1), 70-77. https://doi.org/10.1080/10106040008542142

Magaji, Y. & Sanusi, Y. A. (2021). Evaluation of hydrocarbon prospect in Lema area, western parts of Sokoto Basin, Nigeria, based on analysis of high-resolution aeromagnetic data. Quest Journals Journal of Research in Environmental and Earth Sciences, 7(4), 46–61.

Miller, H. G. & Singh, V. (1994). Potential field tilt: a new concept for location of potential field sources. J. Appl. Geophys. 32, 213–217.

Mustapha A. O. (1992). Biogeochemical technique applied in uranium exploration. Journal Mineral Geology 1992; 28:158-161.

Mwaniki, M. W., Matthias, M. S. & Schellmann, G. (2015). Application of remote sensing technologies to map the structural geology of central Region of Kenya. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 8(4), 1855-1867. https://doi.org/10.1109/JSTARS.2015.2395094

Nabighian, M.N. (1972). The analytic signal of two-dimensional magnetic bodies with polygonal cross-section: its properties and use for auto mated anomaly interpretation. Geophysics. Society of Exploration Geophysicists 37(3):507–517.

Okujeni, C.D. (1987). Biogeochemical investigation into possible use of leaf and bark samples of some savannah trees in prospecting for uranium in the Upper Benue Trough. Nigeria Jour. of Sci. Res.1987;1(1):7-13.

Okujeni, C.D. & Funtua II, Ogunmakunwa ZA, Abba SI, Edegbo S. (1988). Geochemical orientation survey for uranium in the Peta syncline and Guburunde horst, Upper Benue Trough. Nigeria Jour. of Sci. Res.;1(2).

Ostrovskiy EA (1975) Antagonism of radioactive elements in well rock alteration fields and its use in aerogamma spectrometric prospecting. Int Geol Rev 17:461–468. https://doi.org/10.1080/00206817509471687

Phillips JD (2007) Geosoft eXecutables (GX's) developed by the U.S. Geological Survey, version 2.0, with notes on GX development from Fortran code: U.S. Geological Survey Open-File Report 2007–1355.

Ramli, M., Yusof, N., Yusoff, M., Juahir, H., and Shafri, H. (2010). Lineament mapping and its application in landslide hazard assessment: a review. Bulletin of Engineering Geology and the Environment, 69(2), 215-233. https://doi.org/10.1007/s10064-009-0255-5.

Rahaman, M. A. (1988). Recent advances in the study of the Basement Complex of Nigeria. In Precambrian geology of Nigeria (pp. 11–43). Geological Survey of Nigeria.

Rahaman, M. A. (1989). Review of basement geology of Southwestern Nigeria. In C. A. Kogbe (Ed.), Geology of Nigeria (2nd ed., pp. 39–56). Rock View Ltd.

Salem, A., Williams, S., Fairhead, J., Ravat, D., & Smith, R. (2007). Tilt depth method: A simple depth estimation method using first-order magnetic derivatives. The Leading Edge, 26, 1502–1505.

Saint Jean Patrick Coulibaly, H., Talnan Jean Honoré, C., Naga, C., Claude Alain Kouadio, K., Régis Mailly DIDI, S., Diedhiou, A. & Savane, I. (2020). Groundwater exploration using extraction of lineaments from SRTM DEM and water flows in Béré region. https://doi.org/10.1016/j.ejrs.2020.07.003.

Soliman, A. & Han, L. (2019). Effects of vertical accuracy of digital elevation model (DEM) data on automatic lineaments extraction from shaded DEM. Advances in space research, 64(3), 603-622. https://doi.org/10.1016/j.asr.2019.05.009.

Suh C.E. & Dada S.S. (1998). Mesostructural and microstructural evidence for a two stage tectono-metallogenic model for uranium deposit at Mika, Northeastern Nigeria: A Research Note. Nonrenewable Resources, 7(1):75-84.

Telford, W.M., Geldart LP, Sheriff RE (1990). Applied geophysics. Cambridge University Press

Turner, D. (1983). Upper Proterozoic schist belts in the Nigerian sector of the Pan-African province of West Africa. Precambrian Research, 21(1–2), 55–79.

Verduzco, B., Fairhead, J. D., Green, C. M. & MacKenzie, C (2004). New insights into magnetic derivatives for structural mapping. Lead. Edge 23, 116–119.