

## Integrated Aeromagnetic and Remote Sensing Assessment of Geological Structures and Mineralization Potential in Iluke And Environs, Kiri Sheet 226 SW, Nigeria

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### ABSTRACT

Remote sensing and aeromagnetic data analysis were conducted, aimed at characterizing basement structural elements that influence mineralization in Iluke. Remote sensing analysis revealed lineament density concentrated in a NW-SE direction. In the aeromagnetic, three lithological zones were revealed on the Analytic Signal (AS) image and confirmed by field work which includes Meta-Sedimentary such as: migmatite-gneiss-quartzite complexes, and undifferentiated schist, the granitoids and metavolcanic rocks. Structures interpreted based on first vertical derivatives (FVD) and analytical signals (AS) of the aeromagnetic data enabled delineation of long, deep, regional, inter-terrain linear structural features that are different from shallow, relatively short local intra-terrain structures. Typical potential mineralized zones are regions where the delineated structures on the Analytic signal coincide with first vertical derivatives anomalies vis-a-vis zones exhibiting high magnetic susceptibility. These characterized zones also coincide with the location of mineralization such as Tourmaline, gold, tantalum, micas observed from field studies. Mineral deposits tend to be dominated regionally by the dominant structural patterns (NW-SE, NE-SW, and E-W) delineated from SRTM and aeromagnetic analysis.

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### INTRODUCTION

Unearthing of geological structures such as geological contacts, foliation, schistosity, shear zones, fold hinges, faults, and fractures as a result of tectonic processes and hydrothermal fluid circulation has been effectively used as an effective signal for the identification of ore deposits (Binam Mandeng *et al.*, 2018).

The Igarra metasediments, situated on a quartzite ridge and forming linear to semi-linear structures, are believed to have been deposited in a miogeosynclinal trough (Odeyemi, 1976). These rocks were later folded and metamorphosed during the Pan-African orogenic event. The rock types in the study area are Migmatite, gneiss, schist quartzite, and granitoids as the major rocks, the minor rocks observed are the amphibolite, pegmatite dykes and veins, as observed on field and under petrographic microscope. (Alfa, *et al* 2024). Metamorphic grades within the Igarra Schist Belt range from greenschist to lower amphibolite facies, typical of Barrovian-type metamorphism (Egbuniwe & Ocan, 2009; Alfa, *et al* 2024). The metapelites contain andalusite-staurolite-garnet assemblages, indicating metamorphic conditions of approximately 550 ± 50 °C and 3 kbar (Omitogun *et al.*, 1991; Egbuniwe & Ocan, 2009).

Contact metamorphism is evident in the form of oval mineral spots (0.5–2 cm) in phyllites and mica schists, especially in the southern parts of the belt near granite plutons (Udinmwun, 2016; Udinmwun *et al.*, 2016a; Egbuniwe & Ocan, 2009). Rahaman (1989) identified three distinct metamorphic events in the pelitic schists, some coinciding with major folding episodes. While remnants of Early Proterozoic crust are preserved (Annor, 1998), the belt is generally considered Pan-African in origin (Turner, 1983; Archanjo *et al.*, 2013). Although the exact age of metasediment deposition remains uncertain, metamorphic cooling ages between 750–450 Ma

have been reported from Rb-Sr and K-Ar isotopic studies (Dada, 2009). Additionally, Kolawole *et al* (2021) investigated the Sn-Ta-Nb mineralization potential of pegmatites in Bunu, highlighting enrichment of these elements in pegmatites around Otafun and Okutose.

Remote sensing technique, which is a crucial low-cost option is frequently employed in reconnaissance field survey. It is an important tool for identifying, mapping, collecting reliable data on geological structures and prospective or target areas, and numerous studies have demonstrated the effectiveness of satellite imagery remote sensing in revealing structures, which in some cases host mineralization and thus serve as important targets for mineral exploration (Pour *et al.*, 2019a, 2019b; 2013; Ramadan, 2013).

Radar data (from the Shuttle Radar Topographic Mission (SRTM)) is one of the remote sensing datasets that has recently been utilized to substantially modify mapping lineaments, a crucial component of hydrothermal systems that regulate the distribution of mineral deposits in varied terrains (Belt *et al.*, 2015; Kinabo *et al.*, 2008; Masoud and Koike, 2011).

Integrating remote sensing images and aeromagnetic data with surface geological information would allow better understanding near subsurface, subsurface and surface geologic structures respectively. Identify lithologic features and pointing out potential mineralization locations, which is an important component of mineral exploration since many mineral resources that outcrop have already been discovered (Abdelkareem *et al.*, 2018; Andressa *et al.*, 2018; Banji *et al.*, 2020; Eldosouky *et al.*, 2017).

Remote sensing, aeromagnetic and field work techniques are essential for delineating these geological structures (lithology and tectonics) and their parameters such elevation size, shape, surface depth (Akinsunmade *et al.*, 2020). These also help as

guide in exploration geologist's difficulties such as in expenses and access in surveying a verse area.

Several study has been carried out but a more concise structural understanding of the study area is required by integrating aeromagnetic, remote sensing and field work. However, these approach will give more comprehensive understanding of geological structures, lithological variations, and mineralization potential of the area.

This study aimed to integrate remote sensing and aeromagnetic data over kiri sheet 226 to delineate and present detailed observations of structural elements that may

influence mineralizing fluids and to explore desirable area of mineral resources, particularly in areas where mineral resources have yet to be discovered.

### Geological Setting

The study area is bounded by latitudes 8° 00' and 8° 15' N and longitudes 6° 00' and 6° 15' E. This area falls within the 1:50,000 topographic map of kiri sheet 226 SW and is accessible by road from Kabba –Kwara road. The study area falls within the crystalline rocks of the Precambrian Basement Complex of Nigeria (Figure 1).

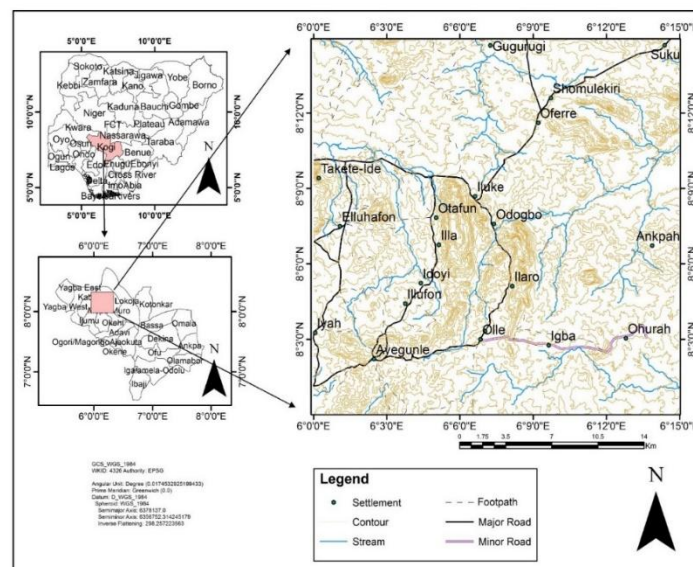


Figure 1: The Location Map of Study Area Covering Sheet 226 Kiri SW

The Nigeria basement complex consists of the following main groups of rocks:

- 1) Migmatite-Gneiss Complex (migmatites-gneisses)
- 2) Metasedimentary and Metavolcanic rocks (Schist, Quartzites, Amphibolite),
- 3) Older Granites (Granites, Granodiorites, Biotite-granite).
- 4) Undeformed Acid and Basic Dykes (muscovite-, tourmaline- and beryl-bearing pegmatite, aplites). (Obaje, 2009; Rahaman and Ocan, 1978). Specifically, the study area is underlain by metasedimentary and metavolcanic rocks of northward extension of Igarra Schist belt (Rahaman and Ocan, 1978). (Figure2). the dominant lithologic units are of migmatite-Gneiss, Schist, Quartzite, granitoids (Porphyritic Granite, Fine grained Granite and Biotite Granite), pegmatite and veins.

## MATERIALS AND METHODS

### Data Acquisition

Base Map-Topographic-Map of sheet 226 Kiri SW sheet On a scale of 1:50,000 was acquired from Nigeria Geological Survey Agency, Abuja data, to analyze the structural elements that influence Mineral deposits and other mineralization in Iluke and its surroundings.

### Remote Sensing Data

In this study, remote sensing data was acquired from NASA Earthdata which was used to deepen our understanding of the structural features of the area that was examined. The study relied on LANDSAT imagery to spot surface characteristics like variations in rock types, alteration zones, and drainage pattern that could hint at the geological structures beneath. The study also tapped into the Shuttle Radar Topography

Mission (SRTM), which has a spatial resolution of 30 meters, to outline lineaments. By analysing these lineaments through shaded relief and slope maps created from the SRTM-DEM, the study was able to pinpoint structural elements such as faults, joints, and fractures which are key factors in understanding what drives mineralization.

### Aeromagnetic Data

Aeromagnetic data for Sheet 226 Kiri was obtained from the Nigerian Geological Survey Agency (NGSA) in a grid format in September 2023. This data, which includes measurements of the Earth's magnetic field intensity, was initially processed using Oasis Montaj to create the Total Magnetic Intensity (TMI) map. This map gives a broad view of the magnetic anomalies present in the study area. To bring out subtle features and pinpoint near-surface structures, the study utilized the Analytic Signal, First Vertical Derivative (1VD) and Second Vertical Derivative (2VD) maps. These derivatives focus on short-wavelength anomalies and reveal shallow magnetic sources. Furthermore, the study then extracted lineaments representing faults, fractures, and other structural elements by analyzing the derivative maps alongside the TMI. This combined approach allowed to identify subsurface structural features that could be linked to mineralization zones in the region. These lineament was plotted on rose diagram and subjected to statistical analysis to ascertain the dominant orientation and percentage in the orientation.

### Field Work

Fieldwork involved getting hands-on with direct observation, measurement, and sampling of rocks to figure out what types



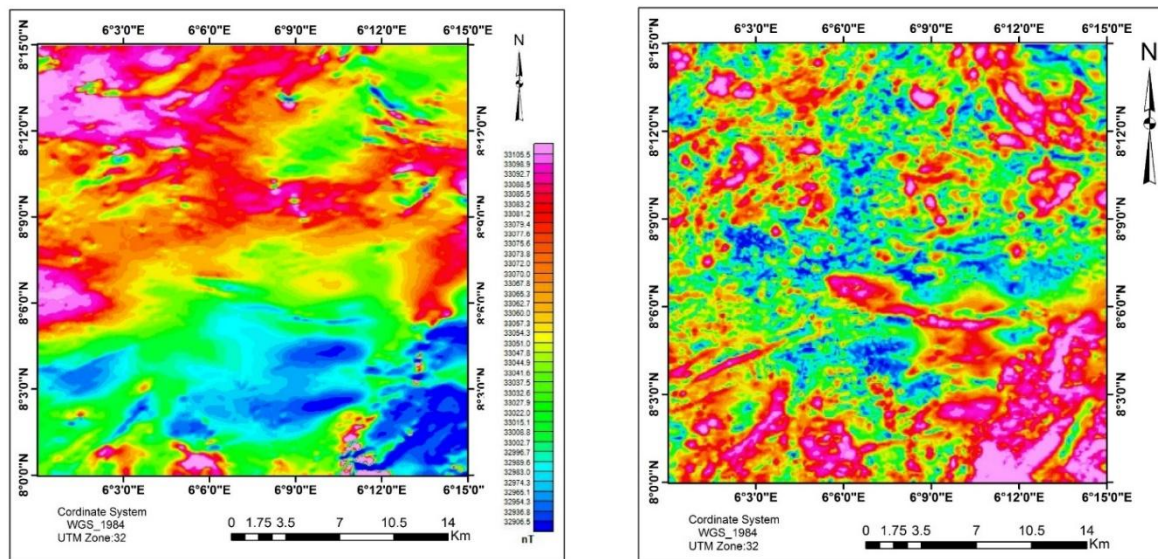


Figure 3a and 3b: Total Magnetic Intensity Map and the Analytic Signals

### First Vertical Derivative (FVD)

These sharpen the edges of magnetic anomalies, gives a clearer contrast between the geological units and the causative structures such as lineaments i.e. faults, joints etc.). These provide a better and clearer picture of the subsurface structure. The first vertical derivative is mostly used over the second because of its ability to suppress noise (Gunn, *et al* 1997) and (Cooper; Cowan 2003).

The first vertical derivatives is used to enhance shallow wavelength features that are as a result of near surface structures obscured by stronger effect of broader regional structures and suppresses the longer wavelength (deeper

sources or regional features. The first vertical derivative map (Figure 4) consists primarily of local anomalies that trend NW-SE/NE-SW and the associated directions of E-W and N-S. It is remarkable to note that short-wavelength anomalies occupied the western part and some portion of the southwestern and northeastern part within the study area, suggesting a comparatively shallow depth of the causative sources compared to the other areas where we can infer a deeper source. FVD and AS images (Figure 4.) display similar anomaly patterns. The pattern may be suggestive of the influence of the contacts of Migmatite complex and other basement components' lithological boundaries.

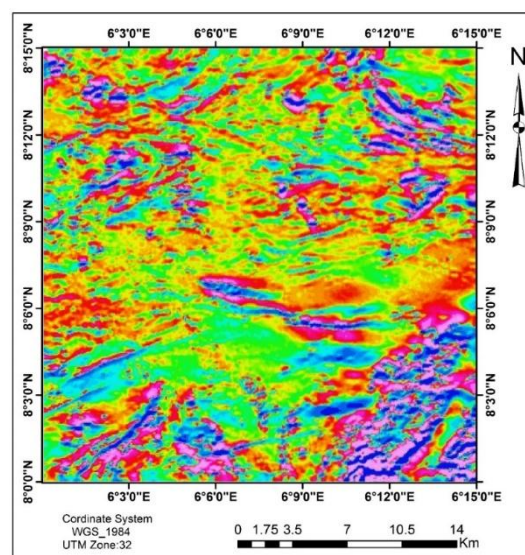


Figure 4: Aeromagnetic Data of the Study Area showing the First Vertical Derivative

### Structural Framework

Faults (lineaments) have long been suggested to have a major interaction with mineral deposits (Figure 5). by supplying

routes to concentrate mineralized fluids into the upper crust and also have been used actively as a reference in exploration ( Holden *et al.*, 2008; Porwal *et al.*, 2006).

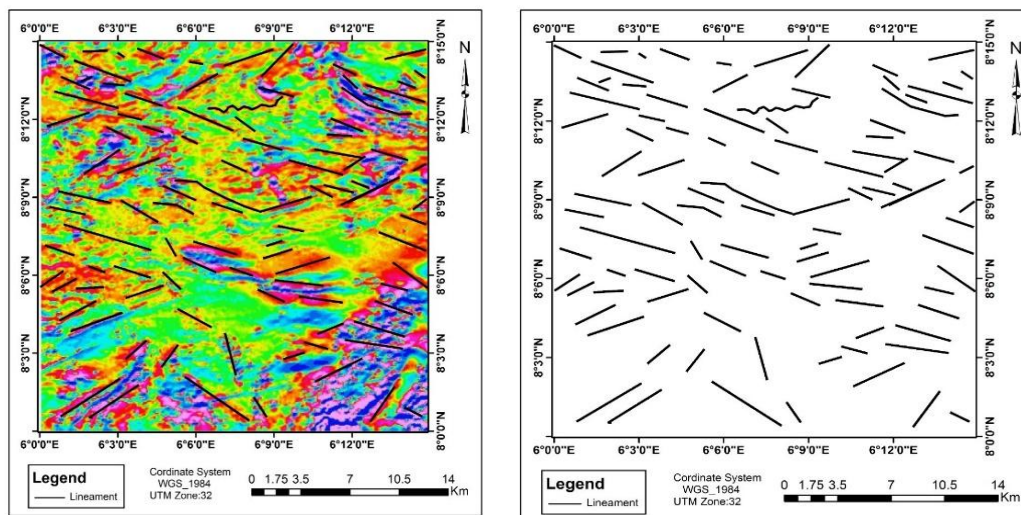


Figure 5: Extracted Lineaments from the First Vertical Derivatives and Lineament Map

For lineament detection short to considerable length, with 30 m resolution were observed. Aeromagnetic data used in this study proved to be adequate (Figure 5). This resulted in a significant number of extracted lineaments being unexpectedly large, these suggest that the study area has been intensively fractured. The direction of lineaments also

corresponds to the direction and pattern of drainage from field observation, which means that the streams and rivers around are structurally and tectonically controlled. (Figure 5). These lineament was superimposed on the geological map in (Figure 6).

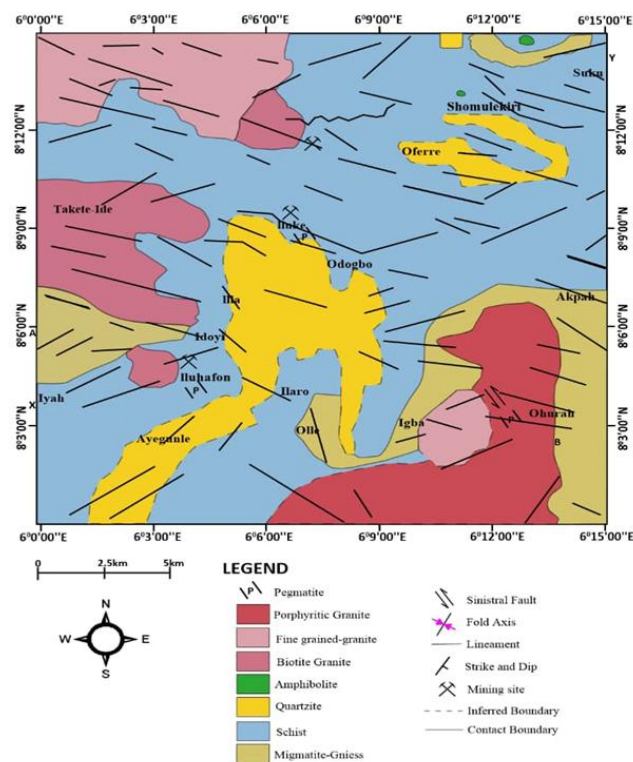


Figure 6: Superimposed Lineament Generated from Aeromagnetic Data on Geological Map

The FVD and TMI were interpreted to deduce geological structures of prominence in the current analysis. In the areas underlying meta-sedimentary rocks and granitoids, the existence of many basement structures suggests that the structural features could retain or serve as a conduits for the

emplacement of mineral deposits. Rose diagram was used to determine the dominant trends, the study which shows a dominant NW-SE and minor NE-SW which signifies the imprint of Pan-African tectonism (Figure 7) and classified based on orientation in (Table 1)

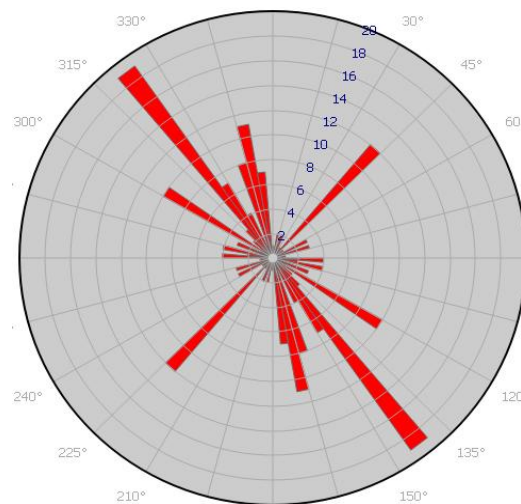


Figure 7: General Trends of the Lineament in the Study Area

Table 1: Lineament Orientation Generated from Aeromagnetic

| SN              | E-W   | NE-SW | NW-SE |
|-----------------|-------|-------|-------|
| 1.NUMBER        | 6     | 21    | 65    |
| 2. (PERCENTAGE) | 6.25% | 21.8% | 71.4% |

The rose diagrams and lineament orientation from lineament data acquired from FVD show major lineament sets with a predominance of NW-SE, NE-SW, and E-W trends. The E-W structural trends and NW-SE are thought to be the product of a compressional N-S tectonic regime possibly pre-pan African or Eburnean, while the NE-SW a structural tendencies are thought to be the product of an E-W oriented deformational regime possibly pan-African as seen on quartzite mapped around Ofere-Shomule kiri and Ayegunle – Iluke (Kolawole 2017 *et al.*, Alfa *et al.* 2024). These trends are believed to have resulted from the earlier pre-Pan-African orogeny (McCurry, 1978; Kolawole *et al.*, 2017 Salawu *et al.*, 2020). Within these regions, E-W trending lineaments reflect older structural tendencies that survived the Pan-African (600 Ma) remobilization, showing that the Precambrian rocks of

this region survived 600 Ma re-arrangements. (Annor, 1995). The NE-SW to ENE-WSW, NW-SE to WNW-ESE structural trends are interpreted to have resulted from major deformation events which are probably Pan-African in age. The Rose diagram of the fractures acquired and lineaments orientation acquired from the lineament from the FVD indicates significant dominant structural patterns of the NW-SE.

#### Mineralization Potential of Iluke and its Environs

The lineament and lineament density generated from the remote sensing and first vertical derivatives (FVD). The zones of peak magnetic anomalies on the AS, FVD, SRTM, and apparent susceptibility images, which also correspond to the high lineament's density zone in Figure 8a and 8b.

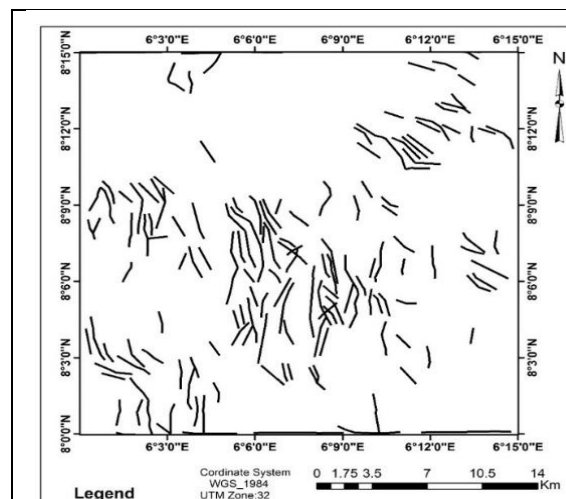
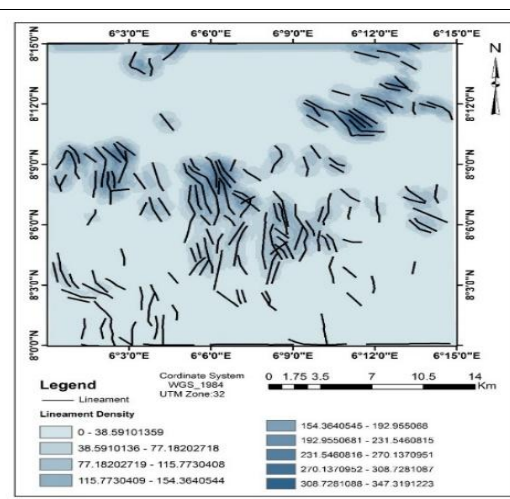


Figure 8a: Remote Sensing Generated Lineaments Map



8b: Lineament Density Map of the Study Area Showing Lineament Density Across the Study Area

From the lineament density and the lineaments in remote sensing and aeromagnetic interpreted data occurrences of minerals deposits might be common in Ayegunle, Olle, Offere and Shomulekiri (Olade, 2020). As a result, high

lineament density zones within the research region indicate high prospective zones where deposits might be investigated, this support the claims of (Zakir *et al.* 1997) which says that mineralization is conspicuous in area of high density often

tagged as prospective zone for mineralization. Estimates of the structural pattern and magnetic anomalies showed that major mineralization within the region is primarily in the direction of NW-SE, and NE-SW.

## CONCLUSION

In this study, it attempted to characterize the structural elements that control mineralization across Iluke and its environs using structural data acquired from the field. However, remote sensing and aeromagnetic also confirmed the trends of fracture system which signify the regional trend to mineralization. The analytical signal map indicates the source anomaly of the paramagnetic, the diamagnetic and the field work reveals presence of metasedimentary, migmatite–gneiss–quartzite complex, and undifferentiated schist and metavolcanic zones which corresponds to the lithology derived from analytic signals, this compares favorably with other derivatives especially in terms of structural trends, edges of anomalous origins, and lithological contacts. From the FVD and interpreted geological structures (lineament) proved very useful to classify long, deep, regional, inter-terrain linear structural features and distinguish them from shallow, relatively short local intra-terrain structures that are laterally confined within a geological terrain. Structures delineated from SRTM and aeromagnetic trends predominantly in NW-SE to NE-SW to N-S, and E-W suggesting a significant effect of Pre-pan-African to Pan-African Orogeny. This prevailing pattern tends to generally control the distribution and emplacement of the deposits within the study area. Remote sensing Studies shows the density of lineaments to be concentrated in NW-SE, the central part of the study area and the NE-SW which also suggest collinear pattern of fracture system and conforms to that of the airborne interpreted. Typical potentially mineralized zones are regions where the delineated structures on the Analytical signal correlate with the first vertical derivatives anomalies vis-a-vis zones with high magnetic susceptibility described as high lineament density areas. It is apparent from the study that if remote sensing and high-resolution aeromagnetic data are carefully studied, it can be an effective method for unraveling structures in the subsurface and may offer useful indicators into the location of valuable mineral occurrences that are concealed deep within the subsurface.

## REFERENCES

- Abdelkareem, M., Kamal El-Din, G. M., & Osman, I. (2018). An integrated approach for mapping mineral resources in the Eastern Desert of Egypt. *International Journal of Applied Earth Observation and Geoinformation*, 73, 682–696.
- Akingboye, A. S., Ademila, O., & Ogunyele, A. C. (2018). Improved magnetic data analyses and enhancement techniques for lithological and structural mapping around Akure, southwestern Nigeria. *Earth Sciences Malaysia*, 2(1), 16–21.
- Akinsunmade, A., Nguyen Dinh, C., Wojas, A., & Tomecka-Suchoń, S. (2020). Characterization of lithological zones of the Isanlu sheet 225, North Central Nigeria, using aerogeophysical datasets. *Acta Geophysica*, 68, 651–665.
- Alfa, M. P., Danbatta, U. A., Jolly, B. A., & Mahmud, I. (2024). Geology and petrography of Iluke, north central basement complex, kiri sheet 226, (Sw of Nigeria). *FUDMA Journal of Sciences*, 8(6), 217–227. <https://doi.org/10.33003/fjs-2024-0806-2980>
- Andressa, T., Penteado, A., & Labouré, C. (2018). Hyperspectral remote sensing applied to mineral exploration in southern Peru: A multiple data integration approaches in the Chapi Chiara gold prospect. *International Journal of Applied Earth Observation and Geoinformation*, 64, 287–300. <https://doi.org/10.1016/j.jag.2017.05.004>
- Annor, A. (1995). U-Pb zircon age for Kabba-Okene granodiorite gneiss: Implication for Nigeria's basement chronology. *African Geoscience Review*, 2, 101–105.
- Annor, A. E., & Freeth, S. J. (1985). Thermo-tectonic evolution of the basement complex around Okene, Nigeria, with special reference to deformation mechanism. *Journal of African Earth Sciences*, 28, 269–281.
- Archanjo, C. J., Viegas, L. G. F., Hollanda, M. H. B. M., Souza, L. C., & Liu, D. (2013). Timing of the HT/LP transpression in the Neoproterozoic. *Journal of Structural Geology*.
- Banji, N., Ogunmola, J., Sunday, L., Ajadi, J., Saleh, A., & Sunday, S. (2020). Aeromagnetic and remote sensing evidence for the structural framework of the middle Niger and Sokoto basins, Nigeria. *Physics of the Earth and Planetary Interiors*, 309, Article 106583.
- Bierlein, F. P., Murphy, F. C., Weinberg, R. F., Lees, T., & Craton, Y. (2006). Distribution of orogenic gold deposits in relation to fault zones and gravity gradients: Targeting tools applied to the Eastern. *Mineralium Deposita*, 41, 107–126.
- Binam Mandeng, E. P., Bondje` Bidjeck, L. M., Takodjou Wambo, J. D., Taku, A., Bineli Betsi, T., Solange Ipan, A., Tchami Nfada, L., & Bitom Dieudonné, L. (2018). Lithologic and structural mapping of the Abiete Toko gold district in southern Cameroon, using Landsat 7 ETM+/SRTM. *Comptes Rendus Geoscience*.
- Burke, K. C., & Dewey, J. F. (1972). Orogeny in Africa. In T. F. J. Dessauvage & A. J. Whiteman (Eds.), *African geology* (pp. 583–608). University of Ibadan Press.
- Cooper, J. R. G., & Cowan, D. R. (2003). The application of fractional calculus to potential field data. *Exploration Geophysics*, 34(4), 51–56.
- Dada, S. S. (2008). Proterozoic evolution of the Nigeria-Borborema Province. In R. J. Pankhurst, R. A. Trouw, B. B. Brito Neves, & M. J. De Wit (Eds.), *West Gondwana: Pre-Cenozoic correlations across the South Atlantic region* (Geological Society of London Special Publication, pp. 121–136). Geological Society of London.
- Egbuniwe, I. G., & Ocan, O. O. (2009). Selection of fieldwork area for teaching/training: Igarra area as an example. In D. O. Lambert-Aikhionbare & A. I. Olayinka (Eds.), *Proceedings of field mapping standardization workshop* (pp. 79–95). University of Ibadan Press.
- Eldosouky, A. M., Abdelkareem, M., & Elkhateeb, S. O. (2017). Integration of remote sensing and aeromagnetic data for mapping structural features and hydrothermal alteration zones in Wadi Allaqi area, South Eastern Desert of Egypt. *Journal of African Earth Sciences*, 130, 28–37.

- Gunn, P. J., FitzGerald, D., Yassid, N., & Dart, P. (1997). New algorithms for visually enhancing airborne geophysical data. *Exploration Geophysics*, 28(1–2), 220–224.
- Holden, E., Dentith, M., & Kovesi, P. (2008). Towards the automated analysis of regional aeromagnetic data to identify regions prospective for gold deposits. *Computers & Geosciences*, 34, 1505–1513.
- Kinabo, B. D., Hogan, J. P., Atekwana, E. A., Abdelsalam, M. G., & Modisi, M. P. (2008). Fault growth and propagation during incipient continental rifting: Insights from a combined aeromagnetic and Shuttle Radar Topography Mission digital elevation model investigation of the Okavango Rift Zone, northwest Botswana. *Tectonics*, 27(3), 1–16.
- Kolawole, M. S., Idakwo, S. O., & Ameh, E. G. (2021). Sn-Ta-Nb mineralization potential of pegmatitic bodies in Bunu area, part of Kabba-Lokoja-Igarra Schist Belt, SW Nigeria. *LITHOS*, 400, Article 106426.
- Masoud, A. A., & Koike, K. (2011). Auto-detection and integration of tectonically significant lineaments from SRTM DEM and remotely-sensed geophysical data. *ISPRS Journal of Photogrammetry and Remote Sensing*, 66, 818–832.
- McCurry, P. (1978). *Geology of degree sheets 19 (Zuru), 20 (Chafe), and part of 19 (Katsina)* (Overseas Geology and Mineral Resources Publication No. 53). Her Majesty's Stationery Office.
- Obaje, N. G. (2009). *Geology and mineral resources of Nigeria*. Springer.
- Odeyemi, I. B. (1976). Preliminary report in the relationships of the basement complex rocks around Igarra, Mid-west. In C. A. Kogbe (Ed.), *Geology of Nigeria* (pp. 59–63). Elizabethan Publishing.
- Odeyemi, I. B. (1988). Lithostratigraphy and structural relationships of the upper Precambrian metasediments in Igarra area, southwestern Nigeria. In *Precambrian geology of Nigeria* (pp. 111–125). Geological Survey of Nigeria.
- Olade, M. A. (1978). General features of a Precambrian iron deposit and its environment at Itakpe Ridge, Okene, Nigeria. *Transactions of the Institution of Mining and Metallurgy*, 87, 81–89.
- Olade, M. A. (2020). Geological re-evaluation of Nigeria's iron ore deposits as raw materials for a viable iron and steel industry. *Journal of Mining and Geology*.
- Omitogun, A. A., Caby, R., & Debat, P. (1991). Le métamorphisme pan-Africain de la partie centrale de la zone mobile du Nigéria (Ceinture schistuse d'Igarra s.l.). *Comptes Rendus de l'Académie des Sciences, Série II*, 313, 1417–1423.
- Porwal, A., John, E., Carranza, M., & Hale, M. (2006). Tectonostratigraphy and base-metal mineralization controls, Aravalli province (western India): New interpretations from geophysical data analysis. *Journal of Asian Earth Sciences*, 29, 287–306.
- Pour, A. B., Park, T. Y. S., Park, Y., Hong, J. K., Muslim, A. M., Läufer, A., Crispini, L., Pradhan, B., Zoheir, B., Rahmani, O., Hashim, M., & Hossain, M. S. (2019a). Landsat-8, advanced spaceborne thermal emission and reflection radiometer, and WorldView-3 multispectral satellite imagery for prospecting copper-gold mineralization in the northeastern Inglefield Mobile Belt (IMB), northwest Greenland. *Remote Sensing*, 11(20), Article 2417.
- Pour, A. B., Park, Y., Park, T. Y. S., Hong, J. K., Hashim, M., Woo, J., & Ayoobi, I. (2019b). Evaluation of ICA and CEM algorithms with Landsat-8/ASTER data for geological mapping in inaccessible regions. *Geocarto International*, 34(11), 1178–1198.
- Rahaman, M. A., & Ocan, O. (1978). On relationship in the Precambrian migmatite-gneiss of Nigeria. *Journal of Mining and Geology*, 15, 23–30.
- Ramadan, T. M. (2013). Application of remote sensing in exploration for uranium mineralization in Gabal El Sela area, South Eastern Desert, Egypt. *The Egyptian Journal of Remote Sensing and Space Sciences*, 16, 199–210.
- Salawu, B. N., Ogunmola, J., Sunday, L., Ajadi, J., Saleh, A., & Sunday, S. (2020). Aeromagnetic and remote sensing evidence for structural framework of the middle Niger and Sokoto basins, Nigeria. *Physics of the Earth and Planetary Interiors*, 309, Article 106583.
- Turner, D. C. (1983). Upper Proterozoic schist belts in the Nigerian sector of the Pan-African province of West Africa. *Precambrian Research*, 21(1–2), 55–79.
- Udinmwun, E., Oden, M. I., & Danbatta, U. A. (2016c). *Strain conditions tracked by metamorphic spots in the Igarra schist belt, southwestern Nigeria* [Abstract]. Season of Rahaman, Book of Abstracts for Professionals" Symposium (p. 14).
- Udinmwun, E., Oden, M. I., Rufai, A., & Asinya, E. A. (2016b). Structural control on mineral vein geometry in the Igarra schist belt, southwestern Nigeria. *Journal of Earth and Atmospheric Sciences*, 1(1), 10–21.
- Udinmwun, E., Oden, M. I., Ukwang, E. E., & Ibegbulam, E. O. (2016a). Strain conditions indicated by metamorphic spots in the southern Igarra schist belt, southwestern Nigeria. *Archives of Current Research International*, 6(3), 1–9.
- Zakir, F. A., Mohammed Qari, H. T., & Most, M. E. (1999). A new optimizing technique for preparing lineaments density maps. *International Journal of Remote Sensing*, 20(6), 1073–1085.
- Zoheir, B., & Emam, A. (2012). Integrating geologic and satellite imagery data for high-resolution mapping and gold exploration targets in the South Eastern Desert, Egypt. *Journal of African Earth Sciences*, 66–67, 22–34.
- Zoheir, B., El-Wahed, M. A., Pour, A. B., & Abdelnasser, A. (2019). Orogenic gold in transpression and transtension zones: Field and remote sensing studies of the Barramiya-Mueilha sector, Egypt. *Remote Sensing*, 11(18), Article 2122.

