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Investigation of Potential Mineral Entrapment Using Airborne Magnetic and Radiometric Data of Ado-Ekiti, Southwestern Nigeria

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ABSTRACT

In this work the mineral entrapment potentials of Ado-Ekiti were assessed using the airborne magnetic and radiometric data collected from the Nigerian Geological Survey Agency. To define structural patterns, to delineate lithological boundaries and to estimate depths to magnetic sources, the study utilizes a complete suite of magnetic data-processing techniques such as reduction-to-equator, first vertical derivative, analytic signal, tilt derivative, upward and downward continuation and 3-D Euler deconvolution. These outputs display the structural trends that are mostly NE–SW and NW–SE and are interpreted to represent the influence of the Pan-African Basement Complex, the principal fracture zones and shear belts and intrusive contacts. The geochemical differences such as variation in the composition of rocks and mineral assemblages can be seen in the maps of potassium, thorium and uranium and the ternary composites on the study area resulted from radiometric interpretation. As suggested by the spatial relationships between the felsic units, the pegmatite bodies and the alteration zones, high values for K, Th and U outline the areas affected by the hydrothermal processes. Coordinated magnetic and radiometric results give a good reinforcement in identifying the favourable targets. Magnetic lineament crossings of radiometric highs are known in a few places and are interpreted as prospective areas where the rocks are structurally controlled for concentration of minerals, and where alteration or mineralization of rocks occurs. The Euler solutions indicate depths ranging from shallow (~100 m) to deeper (>1 km) and some of these are very deep into the subsurface and could include mineralised systems.

INTRODUCTION

The increasing global demand for critical minerals driven by the transition to low-carbon energy systems, electric vehicles, and advanced technologies has intensified the need for efficient exploration techniques capable of identifying concealed mineral deposits(Choko et al., 2022, Oluyemoh et al., 2025) Various gold-bearing and non-gold bearing metallic and non-metallic mineral deposits like tantalite, columbite, tin, lead-zinc and gemstones have been found in the Precambrian to early Paleozoic basement rocks(Kaura et al., 2026, Umar et al., 2017,Abdulsalami et al., 2025) Ado Ekiti, located within the Precambrian Basement Complex of southwestern Nigeria, comprises migmatite-gneiss, granitic intrusions, charnockites, quartzites, and pegmatitic bodies that were emplaced during the Pan-African orogeny. Mineral entrapment is primarily controlled by the interplay of lithology, structural deformation, and hydrothermal fluid migration. Faults, fractures, shear zones, and intrusive contacts commonly act as conduits and traps for mineralizing fluids, whereas favourable host rocks promote the concentration and preservation of economic (Jack et al., 2025, Ohaegbuchu et al., 2026, Ogunleye et al., 2026)

As near-surface mineral resources become progressively depleted, exploration strategies increasingly rely on integrated geophysical methods to delineate favourable geological environments for mineralization. Among these methods, airborne magnetic and gamma-ray spectrometric surveys provide rapid, high-resolution, and cost-effective datasets for mapping lithological variations, structural features, and hydrothermal alteration associated with mineral deposits (Samaila et al., 2025, Ishola, 2026, Olufemi et al., 2026,Arogundade et al., 2022, Ogunseye et al., 2015).The traditional methods of mineral exploration in Nigeria are geological mapping, Geochemical sampling and few ground geophysical surveys. These approaches, however, are labor intensive and expensive and often underestimate mineralization in low exposure and/or rough terrain. The rapid, cost effective regional coverage using high resolution airborne geophysical surveys to map the subsurface geology and to define the potential mineralization zones has transformed mineral exploration (Ebele et al., 2024; Ogah and Abubakar, 2024; Egbeyale et al., 2022).

Magnetic and radiometric surveys have proven to be very useful in basement terrains where they can identify a control on mineralization, lithological changes, and delineate alteration zones associated with potential mineral deposits. Airborne magnetic data are particularly effective for delineating concealed basement structures and estimating the geometry of magnetic sources, while airborne radiometric data reveal the spatial distribution of potassium (K), equivalent uranium (eU), and equivalent thorium (eTh), which are valuable indicators of lithological variation and hydrothermal alteration (Ekwok et al., 2024).

The Ado-Ekiti region is known to be one of the mineral-prospective regions, but there is no detailed and integrated interpretation of available high-resolution airborne magnetic and radiometric data for regional mineral targeting in the region. Most of the existing studies have been localized or concentrated on a single geophysical data set, with many opportunities for mineral prospectivity mapping that integrates multiple data sets (Ojo et al., 2024, Amigun et al., 2024, Ordonez et al.,2024, Abubakar et al., 2023, Ogungbemi et al., 2017, Alabi et al., 2025). Existing studies in the area were mainly geological mapping and small-scale geochemical surveys with a lack of integration of geophysical techniques to define the controls on structure in the subsurface. (Alabi et al., 2025, Iwabi et al., 2026, Ishola et al., 2026). This knowledge gap constrains effective mineral exploration and resource evaluation. Therefore, this study integrates high-resolution airborne magnetic and radiometric data to delineate structural controls, characterize lithological variability, identify alteration signatures, and map prospective mineral entrapment zones in Ado Ekiti, thereby providing a robust geophysical framework for future exploration and sustainable mineral resource development.

MATERIALS AND METHODS

Study Area

The study area is located in the capital city of Ekiti State, Ado-Ekiti located in South western part of Nigeria. It is located within the geographic range of 7°30′N – 8°00′N and 5°00′E – 5°30′E with an area of about 1500 km². Major roads are well-developed in the area, providing easy access to Lagos, Ibadan and other major cities. The terrain is mostly hilly varying from 200 m to 600 m above sea level. The geological map of the study area is presented here (Figure 1) that represents the spatial distribution of the major rock units of the study area, which are Older Granite, Charnockite and Migmatite Gneiss.

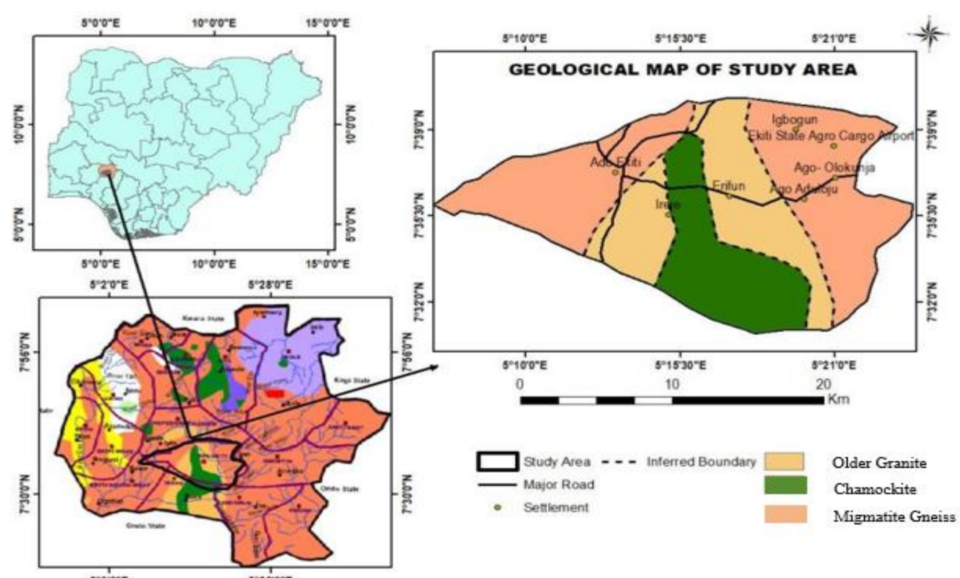

Figure 1: Geological Map of Study Area (Ado-Ekiti), showing major lithological units and the location of the study area within Nigeria and Ekiti State

Geological Background

The study area falls within the basement complex of Nigeria which is part of the Pan-African mobile belt. The basement complex rocks are Precambrian to early Paleozoic, and have been affected by multiple deformation, metamorphism and intrusion events. The major rock units are: (1) Migmatite-Gneiss Complex which is the oldest to have been subjected to high-grade metamorphism; (2) Schist Belts which are linear belts of low to medium grade metasedimentary rocks interpreted as relics of early sedimentary basins; (3) Pan-African Granitoids intruded during the time of formation of the Pan-African orogeny (~600 Ma), including biotite, hornblende and granite gneisses; (4) Pegmatites and Aplites, late-stage intrusions and often containing rare metal mineralisation; and (5) Basic to Ultrabasic Intrusions, small bodies of amphibolites and serpentinites. Structural architecture is represented by NE–SW trending structures developed during the Pan-African period of deformation. Alluvial and primary gold, pegmatite tantalite-columbite, cassiterite, gemstones (tourmaline, beryl, garnet) and industrial minerals (quartz, feldspar, mica) are all recorded mineral occurrences.

Data Acquisition

The airborne geophysical data with sheet number 244 was obtained from the Nigeria Geological Survey Agency (NGSA), under the Nigeria Geological Mapping Project. The air-borne magnetic survey was conducted at an average height of 80 m above ground level (AGL) with a NW – SE flight line spacing of 500 m and a tie line spacing of 2,000 m covering an area of about 55 km x 55 km in the vicinity of Ado-Ekiti. The data on magnetic intensity was obtained using a cesium vapour magnetometer which measured the data in Total Magnetic Intensity (TMI) in nanoteslas (nT). A gamma-ray spectrometer was also flown on the survey aircraft and was used to collect these radiometric data, which gave a Potassium (K %), Uranium (U ppm) and Thorium (Th ppm) concentration. The data processing, filtering, enhancement and visualization were done with the software Oasis Montaj (Geosoft).

Magnetic Data Processing

The processing was carried out systematically, to eliminate the noise and to highlight the anomalies which were then separated from the geologically significant features. The data provided has been pre-processed by using the following corrections: Diurnal correction, IGRF, Tie-line levelling, Micro-levelling. The Diurnal correction avoids the effects of temporal variations in the Earth's magnetic field in the magnetic anomalies. This makes magnetic measurements taken over different times more consistent and accurate. The IGRF correction separates anomalies due to the geological structures such as granite, pegmatite, fault. Consistency between adjacent flight lines can be obtained by the tie-line levelling, and systematic survey errors can be eliminated. The removal of the residual striping and the increased clarity of subtle geological features are referred to as "micro-levelling" (Blum,1999). The corrected data sets therefore serve as a reliable data set to delineate lithological boundaries, structural trends, alteration zones and potential mineralized targets in the Ado-Ekiti area.

A minimum curvature gridding algorithm was used to grid data that was available at a 125 m cell size. The following enhancement filters have been applied: 1st Vertical Derivative (FVD) was used to enhance near surface structures; Reduction to the Equator (RTE) was used to correct for low magnetic inclination; Analytic Signal (AS) filter was applied to define edges of magnetic bodies independent of the direction of magnetization; Tilt Derivative (TDR) was applied to enhance subtle anomalies; and Upward/Downward Continuation was used to separate deep and shallow sources. A geological map was developed and lineaments identified as faults, fractures and lithological contacts were added to the map.

Radiometric Data Processing

The radiometric data were calibrated and noise reduced. The raw counts from the gamma rays were corrected for the background radiation in the aircraft, cosmic radiation, Compton scattering, increase with altitude, and stripping the spectra. Processed results provided concentration grids for K, U and Th (ppm). All three radioelements were used to produce a map, and a ternary radiometric map was created that enabled a colour-coded image to be produced that allowed rock types and alteration zones to be visualised.

3-D Euler Deconvolution

The 3-D Euler decconvolution was performed on the RTE data to locate the magnetic source bodies and to calculate their depths. It is a technique that uses the homogeneous Euler equation:

$$(x - x_0)\frac{\partial T}{\partial x} + (y - y_0)\frac{\partial T}{\partial y} + (z - z_0)\frac{\partial T}{\partial z} = N(B - T) \quad (1)$$

The magnetic field observed, B, at the source location, (x_0, y_0, z_0) and the source geometry, N, (0 = contacts, 1 = dikes, 2 = cylinders). The solutions were computed using a window of size 20 m, a tolerance of up to 15 m deep, a structure index of N = 1, a maximum distance of 1,000 m and a flying height of 80 m. The depth interpretations were kept for reliable solutions (standard deviation < 10%).

RESULTS AND DISCUSSION

Total Magnetic Intensity (TMI) Map

The Total Magnetic Intensity (TMI) map (Figure 2) shows a wide variety of magnetic signatures over the

Ado-Ekiti area which are characterised by strong colour contrasts, representing differences in the magnetic properties of the rocks beneath the surface, structural patterns and potentially areas of mineralisation. High magnetic intensity (red to pink areas) are mainly concentrated around the central part and towards the north-east and south-west and are associated with magnetite-rich rocks (granites and gneisses) and possibly intrusive bodies that could contain pegmatites and iron-rich minerals. The red to pink areas are relatively strong magnetic areas, where rocks have a higher magnetic strength than the surrounding rocks (Abraham & Emetere, 2025, Ugodulunwa et al., 2008, Aliyu,et al., 2020, Alabi et al., 2025).

Green zones refer to areas of moderate magnetic intensity in rocks with mixed gneiss/migmatite facies and/or in lightly altered basement rocks. Zones of low magnetic intensities are typically associated with zones of deep weathering or alteration, schists, quartzites and are represented by blue to deep blue zones, and may be appropriate for hydrothermal mineralization, usually found in shear zones (Abraham & Emetere, 2025, Ugodulunwa et al., 2008).

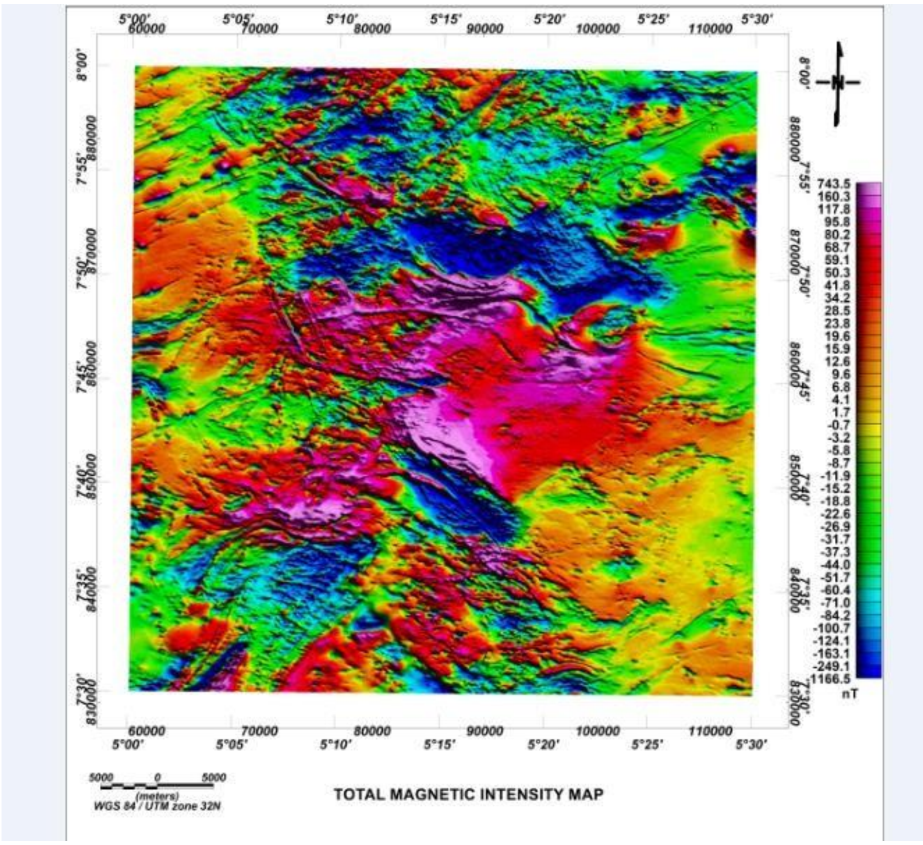

Figure 2: Total Magnetic Intensity (TMI) Map of Ado-Ekiti

Reduction to Equator (RTE) Map

There are notable changes in magnetic intensity along the Reduction-to-Equator (RTE) map (Figure 3) ranging from –124 nT to over +110 nT. This correction allows for the peak of the anomaly to be moved directly over the anomaly source body and improves the accuracy of the structural interpretation. High magnetic intensities are found in the central, south-western and south-eastern parts, and are related to mafic rocks containing magnetite, such as amphiboltes and mafic dykes, that trend in elongated NE–SW and E–W directions, indicating possible faults, shear corridors and intrusive contacts. Low magnetic intensities in the N-NW quadrants correspond to non-magnetic, and weakly magnetic lithologies such as granites, pegmatites and quartz-rich lithologies. (Balogun,2019, Alabi et al., 2025, Martins,et al.,2021, Olomo et al., 2022). All quantitative and derivative analyses were based on the RTE map.

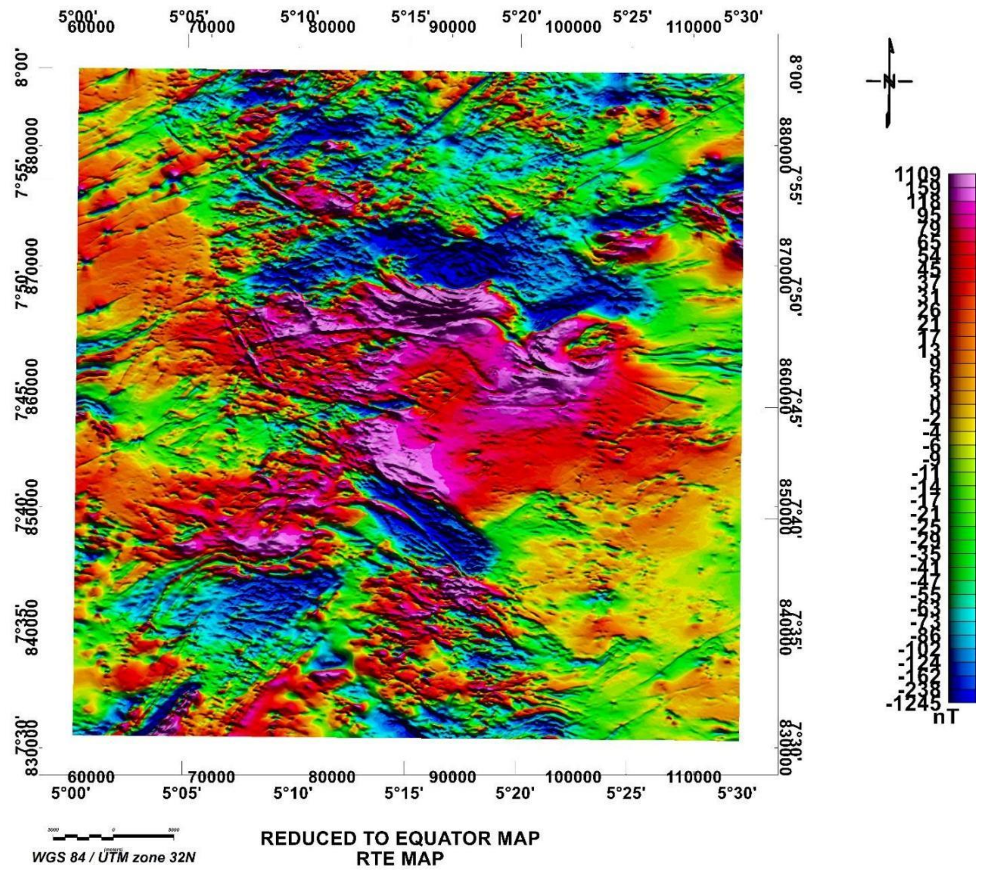

Figure 3: Reduction-to-Equator (RTE) Magnetic Map of Ado-Ekiti

First Vertical Derivative (FVD) Map

In order to improve the magnetic signal and to bring out the high frequency part of the magnetic map, the First Vertical Derivative (FVD) map (Figure 4) was produced to highlight shallow geological structures. Pinkish-greyish areas are areas of low or moderate magnetic range; they are typically located at fracturing and/or weathering, which creates a decrease of magnetic minerals (Abd-Elsadek et al.,2026; Abdelrady et al., 2023; Olomo et al., 2022). Red-pink zones indicate shallow magnetic sources such as vein systems or sharp lithological contacts and/or intrusive bodies (Abd-Elsadek et al.,2026; Faruk et al., 2025; Yusuf et al., 2022; Blakely, 1996). Between large structures are stable areas of the basement as background terrain (green-yellow zones). The tight clustering of the NE-SW and NW-SE trending linear gradients is a strong reflection of the structural grain of the Pan-African Basement Complex (Salawu et al.,2021; Stephen et al.,2024; Mono et al., 2024). These are near surface structural controls that are thought to be primary controls on mineralizing fluid pathways.

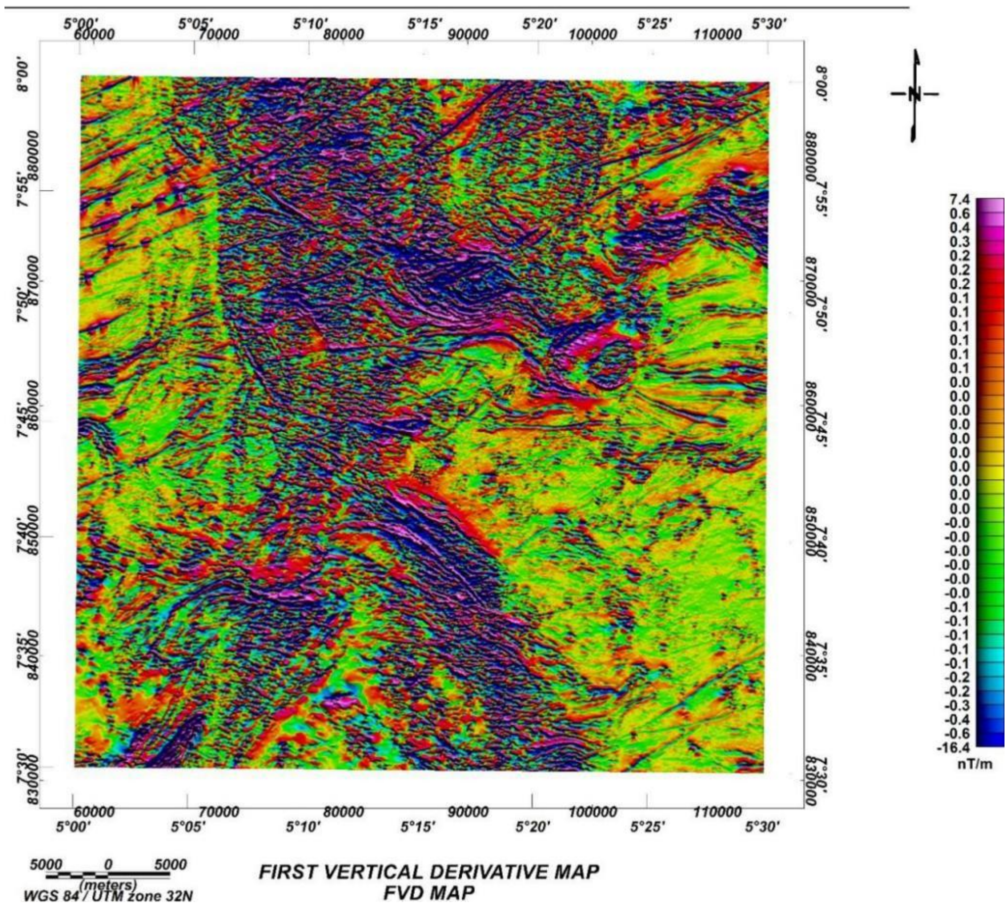

Figure 4: First Vertical Derivative (FVD) Map of Ado-Ekiti

Analytic Signal (AS) Map

The Analytic Signal (AS) map as shown in Figure 5 is particularly useful in low latitude environments since the edges of magnetic bodies are accentuated and the boundaries of bodies buried under magnetic bodies are accentuated regardless of the direction of the magnetization. Red/purple zones are areas of sharp boundaries; shallow magnetic bodies; intrusive contacts and areas of high contrasts in rock properties which is usually associated with dykes, pegmatites, veins, fault controlled intrusions(Ogah and Abubakar, 2024, Yusuf et al., 2022) The blue light blue colours are for deep-seated or weakly magnetic rocks, thick weathered layers or for broad uniform blocks of basement (Akingboye and Ogunyele, 2017, Rajagopalan, 2003) The amplitudes of the analytic signal confirm the most magnetically active zones are found in the central and northwestern corridors following the main NE–SW structuring trends shown in the maps FVD and TDR.

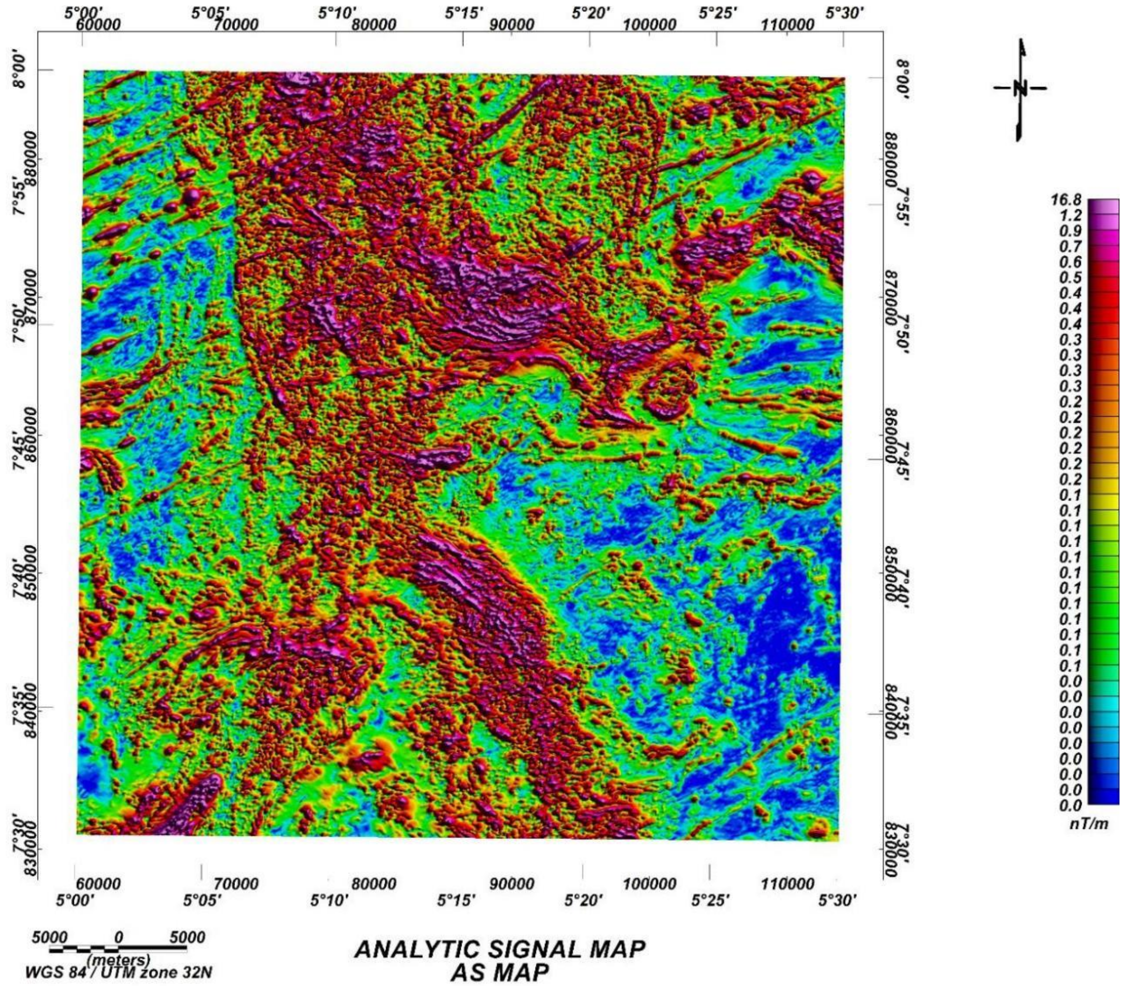

Figure 5: Analytic Signal (AS) Map of Ado-Ekiti

Tilt Derivative (TDR) Map

The Tilt Derivative (TDR) map as shown in Figure 6 provides a greater contrast in subtle magnetic gradients and aids in defining edges of geological bodies, faults and fractures at all depths and amplitudes. The basement terrain is structurally complex, as indicated by the TDR map by a complex of linear and curvilinear anomalies, mostly in the NE-SW and NW-SE trends. The high TDR values (warm colours, red-pink) are found in areas of sharp magnetic contrasts, such as faults, shear zones, lithological contacts, and intrusive margins, which are the sites where the hydrothermal fluids can circulate and where it is common to find mineral entrapment (Miller and Singh, 1994, Verduzco et al., 2004, Salem et al., 2008). The cool colours (blue-green) indicate low TDR (more homogeneous and not very magnetic units), e.g. secondary mineralisation in fractured zones is also possible (Fairhead et al.,2011; Stewart and Miller, 2018).

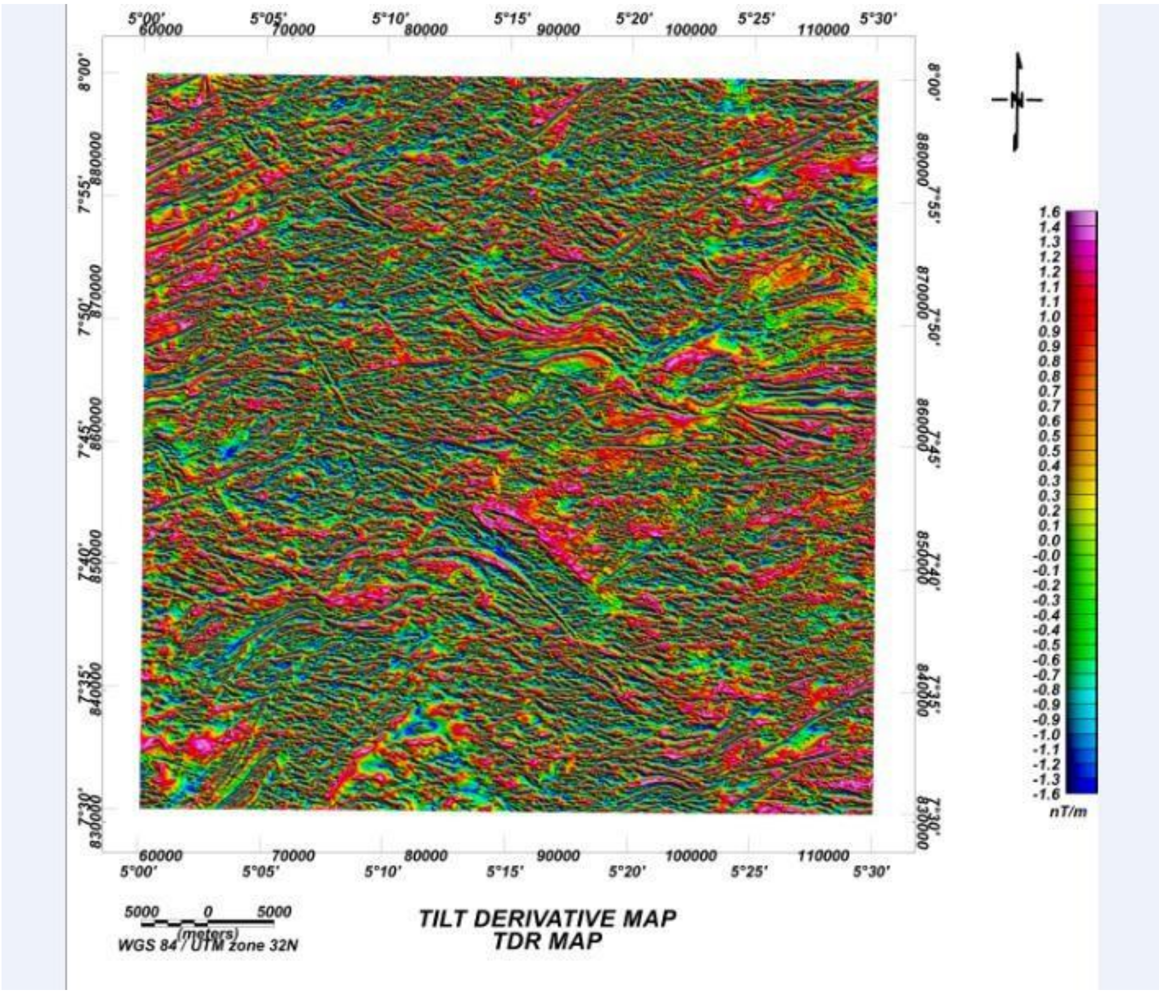

Figure 6: Tilt Derivative (TDR) Map of Ado-Ekiti

Lineament and Structural Mapping

Lineament extraction was carried out to determine subsurface structures that can be suitable subsurface controls for mineral localization. Lineaments were overlaid on the FVD map as illustrated in figure 7, which displays spatial correlation between magnetic gradient transitions and the magnetic features interpreted. Correlation of lineament density with magnetic anomaly boundaries indicate the areas of greatest mineralising fluid migration and accumulation and structural permeability (Ogah and Abubakar, 2024).

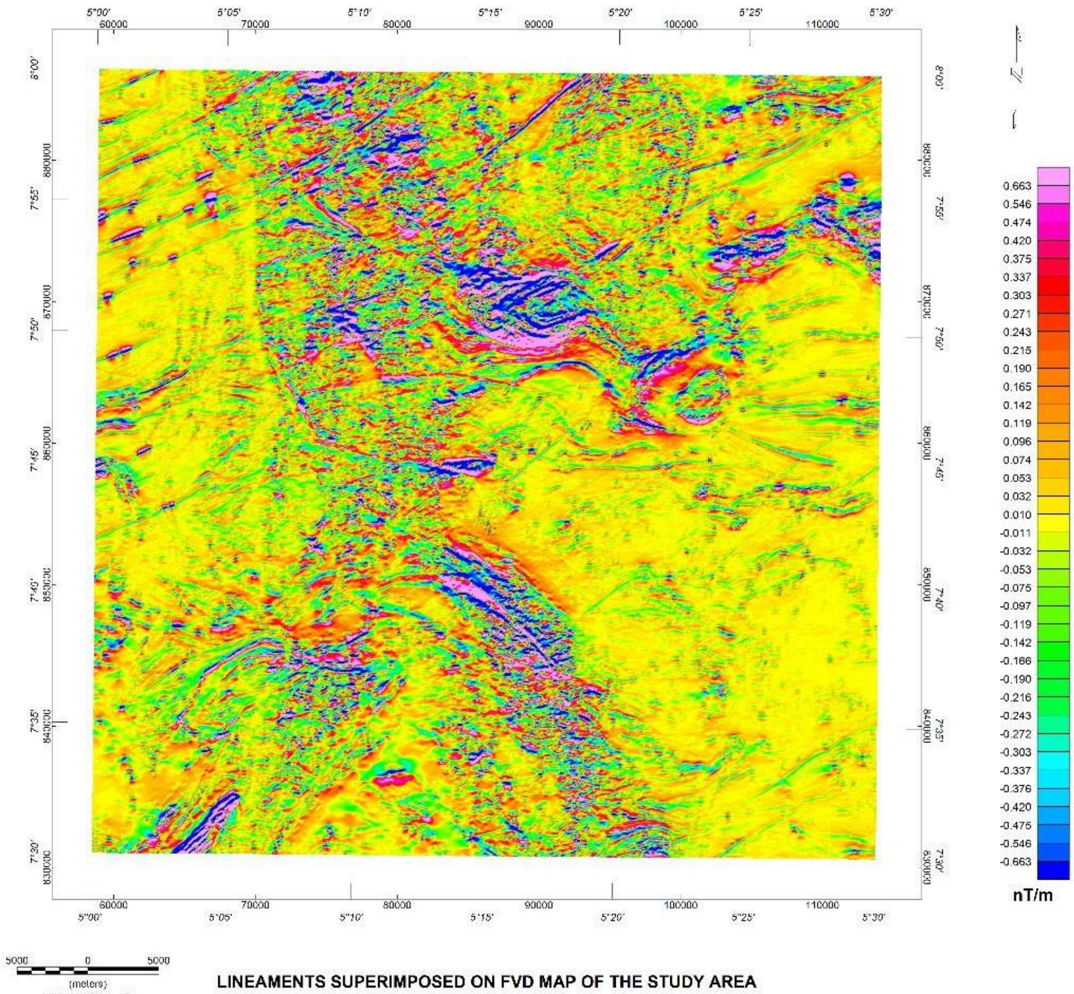

Figure 7: Lineaments Superimposed on FVD Map of Ado-Ekiti

The Ado-Ekiti Lineament Map (Figure 8) is a self-contained Map and has a good number of NE-SW and NW-SE oriented linear features which include some E-W and N-S oriented linear features. The faults, fractures and shear zones are expressed as these lineaments and are within the Precambrian Basement Complex. The lineaments are close together, and are intercut in the central to southern part of the study area, indicating high deformation zones (Olasunkanmi et al., 2018). These zones are structurally weak, very fractured and good transport and entrapment of mineralizing fluids. The fact that these structures coincide with magnetic discontinuities and radiometric anomalies suggests that lithological contacts and possible hydrothermal alteration zones were fault controlled and are significant controls on the trapping of minerals in basement terrains (Dentith and Mudge, 2014).

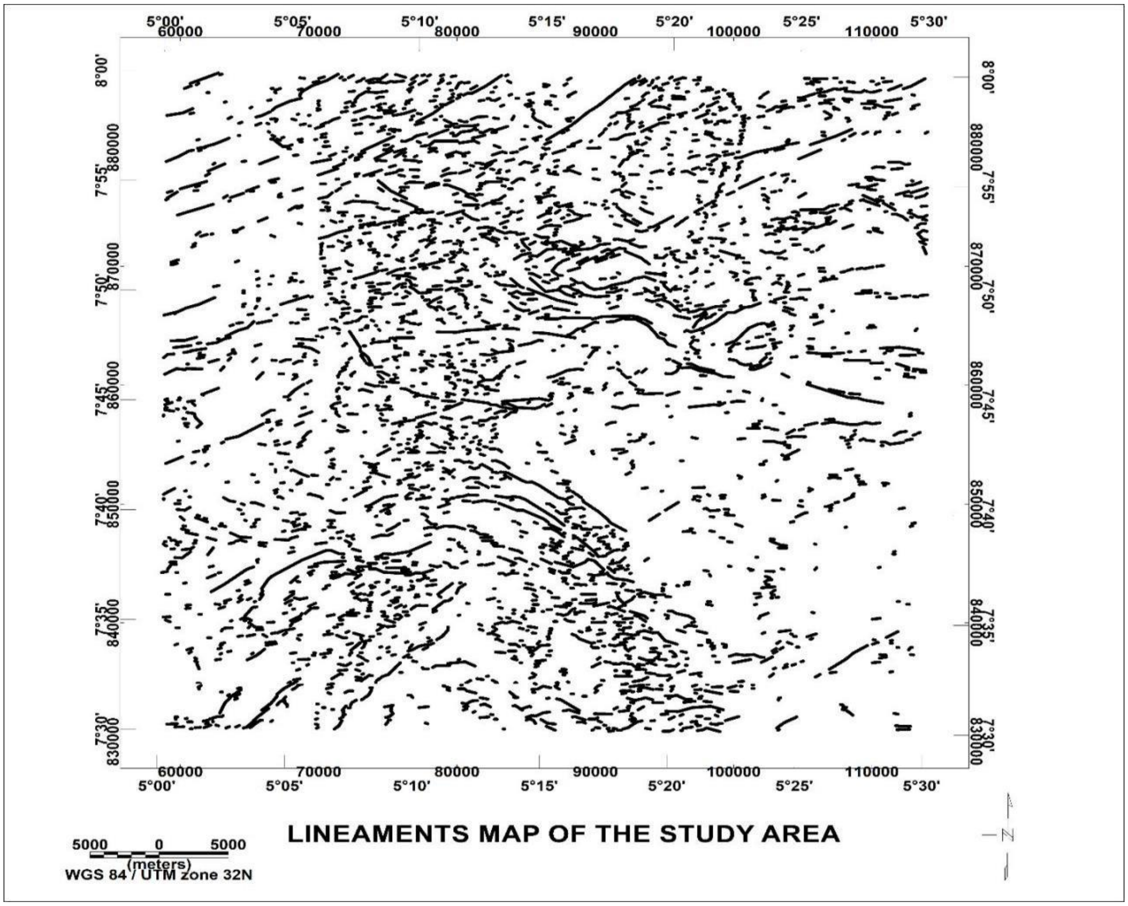

Figure 8: Lineament Map of Ado-Ekiti

Potassium (K) Radiometric Map

The distribution of rock units and minerals containing high concentration of potassium in the Ado-Ekiti basement complex is shown on the potassium radiometric map (Figure 9). High potassium concentrations (pink – red zones) are found where there is dominance of felsic and highly altered rocks, such as granites, pegmatites and feldspathic gneisses. High-K areas have been known to contain mineralized pegmatite minerals like tourmaline, mica, columbite-tantalite, and feldspar (Adetunji and Ocan, 2010). Moderate potassium values (yellow–green) are indicative of mixed lithologies of moderately weathered gneissic and migmatitic rocks, which are transition zones around intrusions where moderate enrichment with minerals can happen (Airo,2007). Low potassium values (blue–cyan regions) define mafic (basaltic to gabbroic) rock units, deeply weathered terrains or structurally fractured zones that have lost potassium minerals, the areas of which may correspond to faults and shear zones that are pathways to hydrothermal mineralization and secondary deposits including gold-bearing quartz veins (Akinlalu,2023).

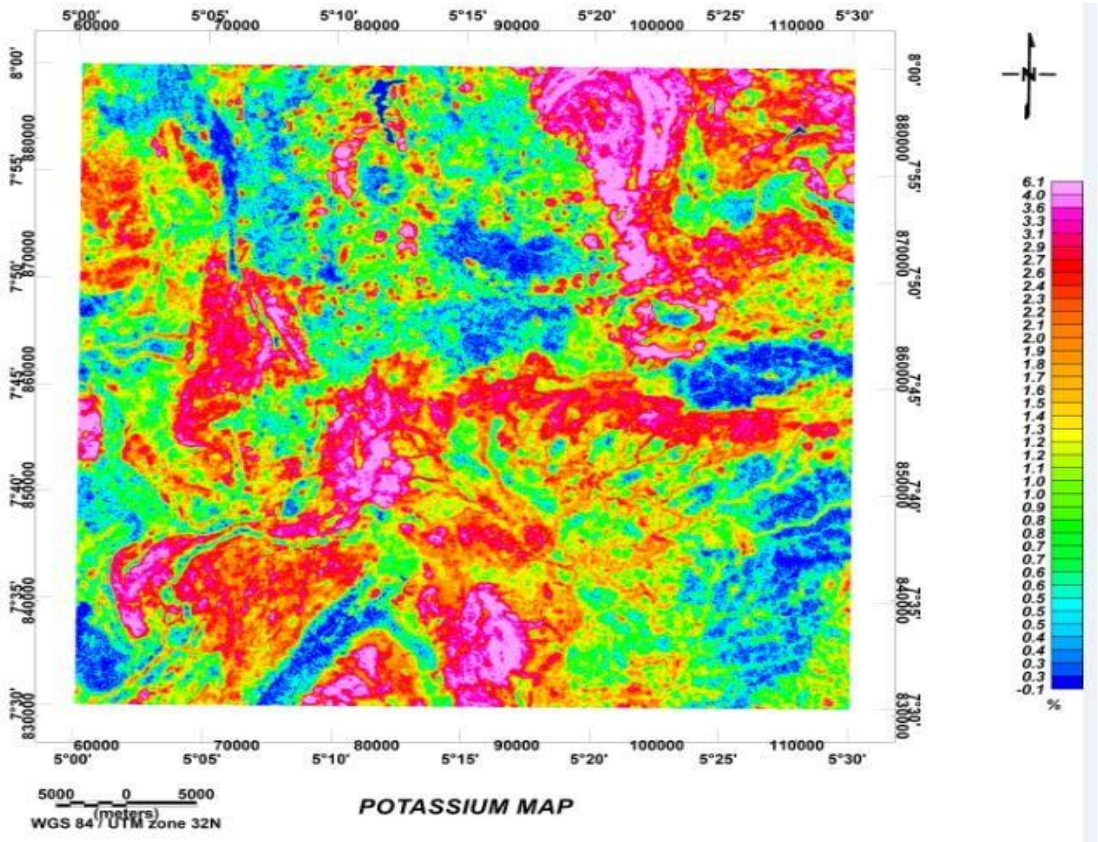

Figure 9: Potassium (K) Radiometric Map of Ado-Ekiti

Thorium (Th) Radiometric Map

The spatial distribution of thorium bearing minerals in Ado-Ekiti basement complex is presented in the thorium map as shown in Figure 10. The felsic, highly evolved and alteration rich rocks (granites, pegmatites and migmatites) with high concentrations of thorium (pink-red zones) are associated with accessories like monazite, allanite, zircon and others (Dentith and Mudge,2014).The high TH values are a good indicator of igneous differentiation and pegmatite bodies, both of which are known hosts of rare metal mineralization such as columbite-tantalite, zircon and rare-earth elements (REEs).(Bradley et al., 2017; Minty et al., 2009). Moderate Th zones (yellow–green) are transitional lithologies or moderately altered basement rocks, and may contain dispersed REE minerals and/or metasomatized zones. Low-Th regions (blue–cyan) are mafic or highly weathered terrains in which thorium-bearing minerals are lacking, but which may be of value as sites of hydrothermal mineralization (e.g., gold-bearing quartz veins) that is not necessarily associated with thorium enrichment (Minty et al., 2009; Dentith and Mudge, 2014; Adetunji and Ocan, 2010).

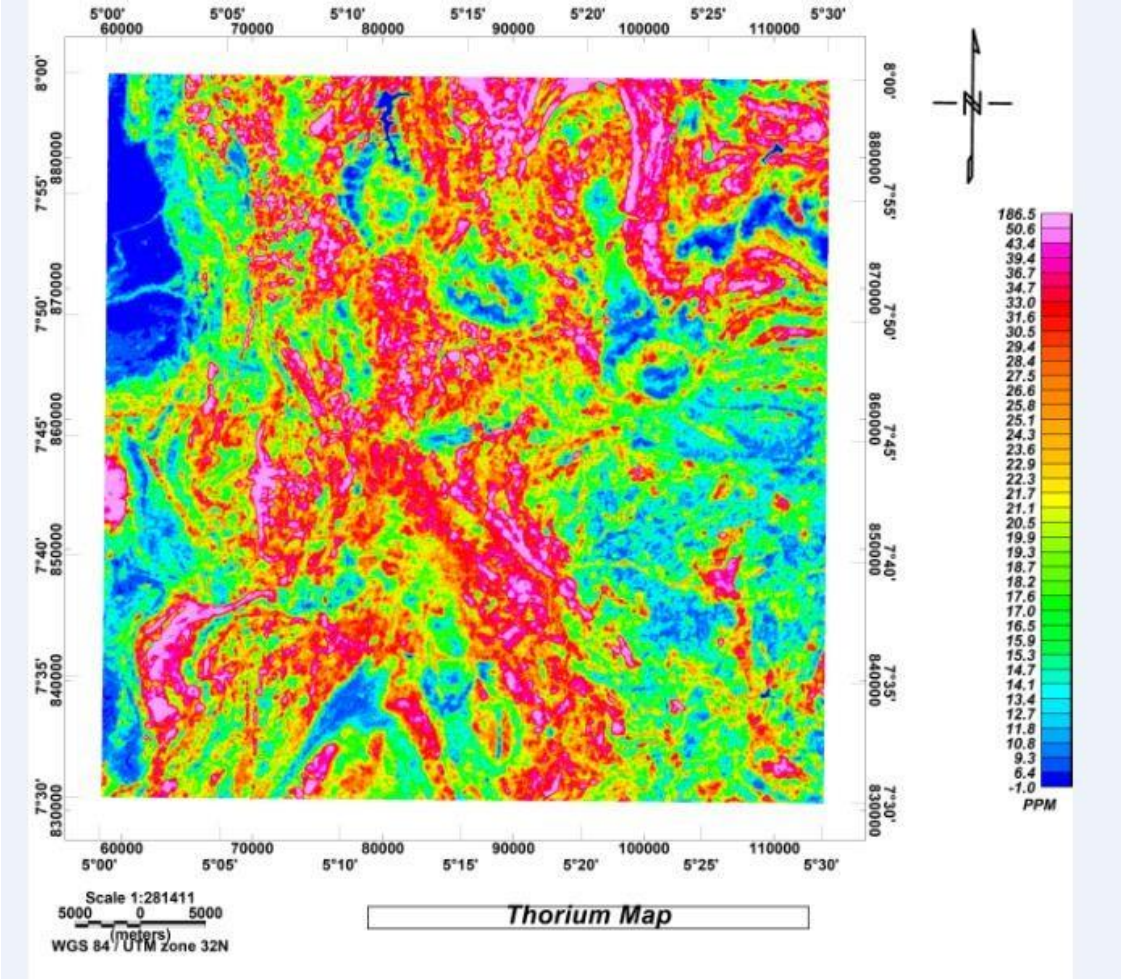

Figure 10: Thorium (Th) Radiometric Map of Ado-Ekiti. High-Th zones (up to 186.5 ppm) mark evolved felsic and pegmatitic units; low-Th corridors correlate with mafic belts and shear zones

Uranium (U) Radiometric Map

The uranium radiometric map (Figure 11) shows equivalent uranium concentrations between –0.8 and 33.3 ppm. High-U zones (pink-red; ~6 to 33 ppm) are grouped in the central to NE side of the map and are interpreted as being radiogenic and felsic hosted and are likely granite/pegmatite bodies and highly altered gneisses (IAEA, 2013). These anomalies are generally long and narrow in a NE – SW and NW – SE trend, indicating the uranium is concentrated along fractures and shear zones. This type of pattern is typical of the hydrothermal uranium redistribution which indicates that the late-stage mineralizing fluids moved along pre-existing tectonic structures (Dickson and Scott, 1997). The background for mixed granitogneissic terrain is given by moderate (green – yellow, ~2 – 4.5 ppm) values. Low values (blue; <1.5 ppm) are found at the edges of the W–SW, and in linear depressions, representing mafic or quartzose units, and possible areas of leaching (Kearey et al.,2002; IAEA, 2013).

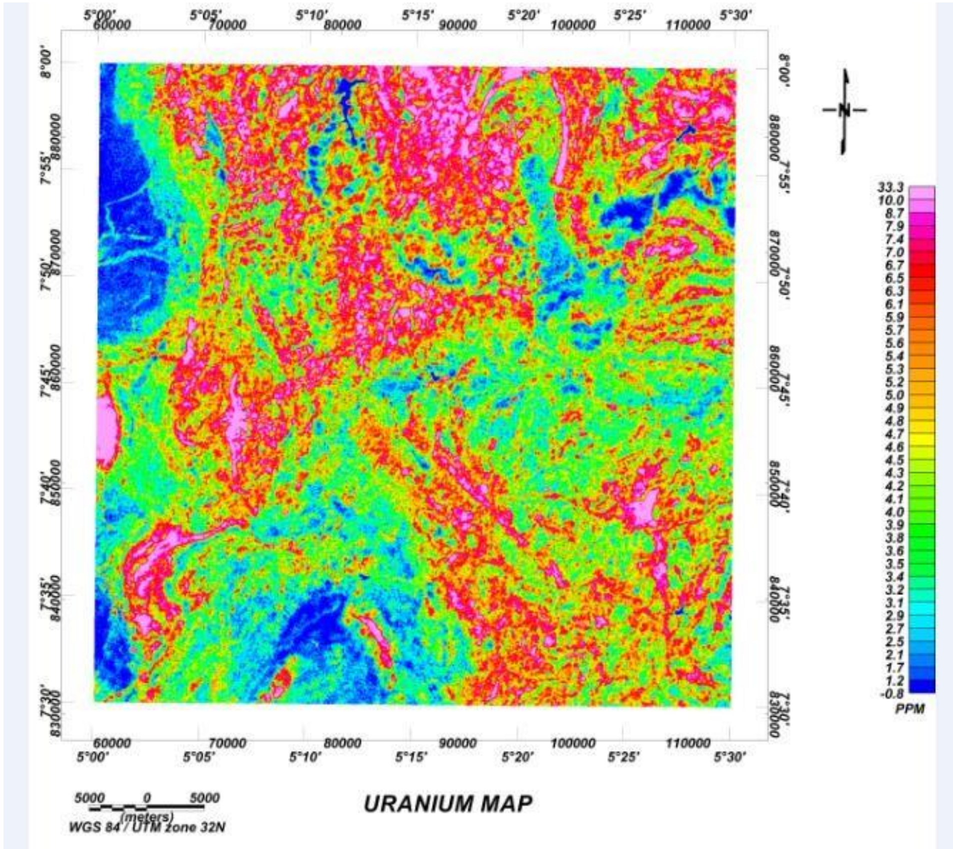

Figure 11: Uranium (U) Radiometric Map of Ado-Ekiti. High-U anomalies (up to 33.3 ppm) are structurally controlled along NE–SW fractures; blue zones indicate mafic and quartz-rich leached units

Ternary Radiometric Map

A ternary radiometric map (Figure 12) is a ternary map of the concentrations of K, Th and U as an RGB image, giving a complete image of geochemical variation at the surface. The potassium rich zones (red–cyan) are quite widespread, and are interpreted as granitic and migmatitic basement rocks and potassic alteration produced by hydrothermal fluids (Wilford et al., 1992; Dentith and Mudge,2014). Thorium-rich (green–magenta) areas are more localized and associated with relatively unaffected felsic basement units that contain abundant accessories that are relatively resistant to alteration(Minty et al., 2009, Dentith and Mudge,2014) Some uranium enrichment is present along narrow, elongated patterns (blue–yellow) that are thought to be structurally controlled, that is, they are fractures, faults and shear zones in which uranium has been remobilized and re-deposited by mineralizing fluids (IAEA, 2013). The overlying of K- and U-enriched zones with magnetic structural lineaments are significant areas of follow-up mineral exploration.

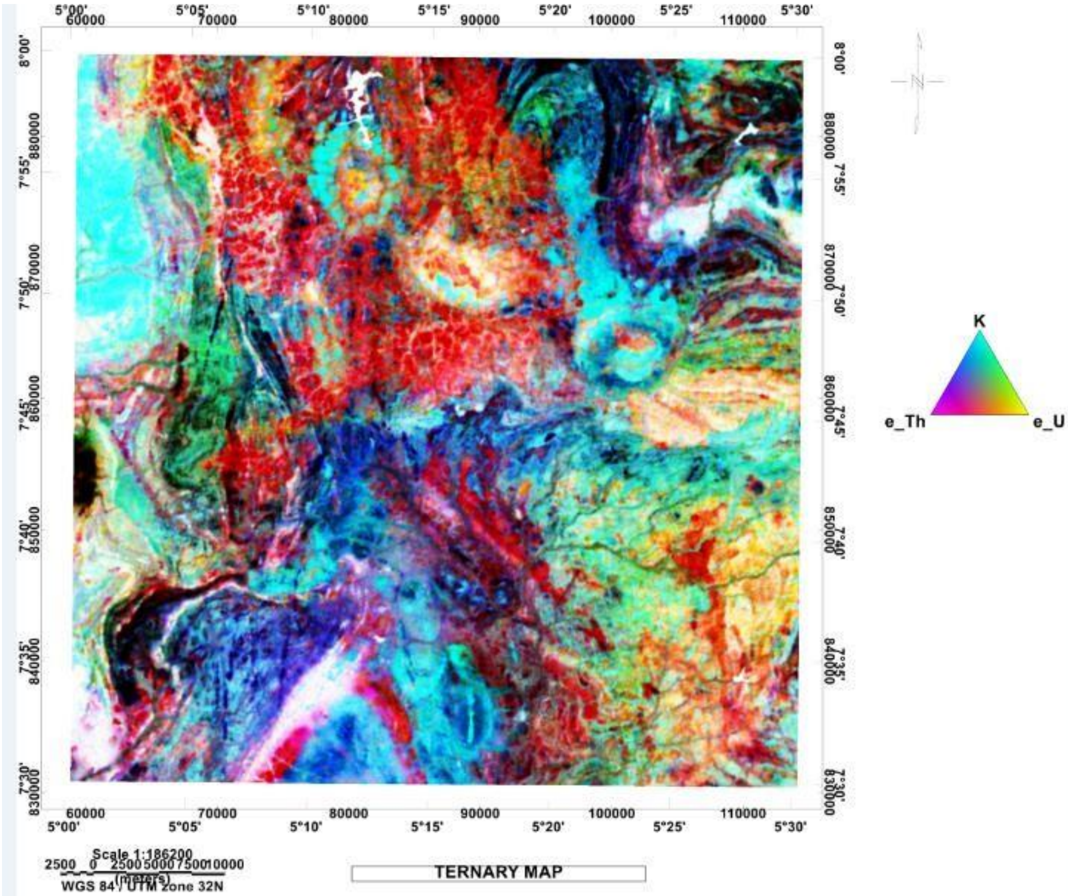

Figure 12: Ternary Radiometric Map of Ado-Ekiti (R = K, G = Th, B = U). Widespread K-rich (red–cyan) zones indicate potassic alteration; narrow U-enriched (blue–yellow) corridors align with structural fractures and shear zones

Upward Continuation Map

The upward continuation mapping (Figure 13) was used to suppress the high frequencies of the magnetic noise from the near surface and magnify the magnetic signals from the deeper sources and thus reveal the wider structural framework of the Ado-Ekiti basement. The broad high magnetic intensities (pink-red zones, up to ~859 nT) are magnetically strong deep intrusive bodies like granites, dolerite dykes or mafic units (Blakely, 1995; Dentith and Mudge, 2014). Low-intensity corridors (green–blue) are areas that reflect less magnetic lithologies like gneisses, schists, fractured or weathered zones (Hinze et al., 2013; Telford, 1990; Clark and Emerson, 1991). The upward continuation map is also smoother and longer wavelengths support the dominant high in the central part of the study area which is currently considered to be a major intrusive mafic or mixed body. In the region, the main structural framework that controls the fluid flow at depth is this regional high and nearby lows. (Dentith and Mudge, 2014).

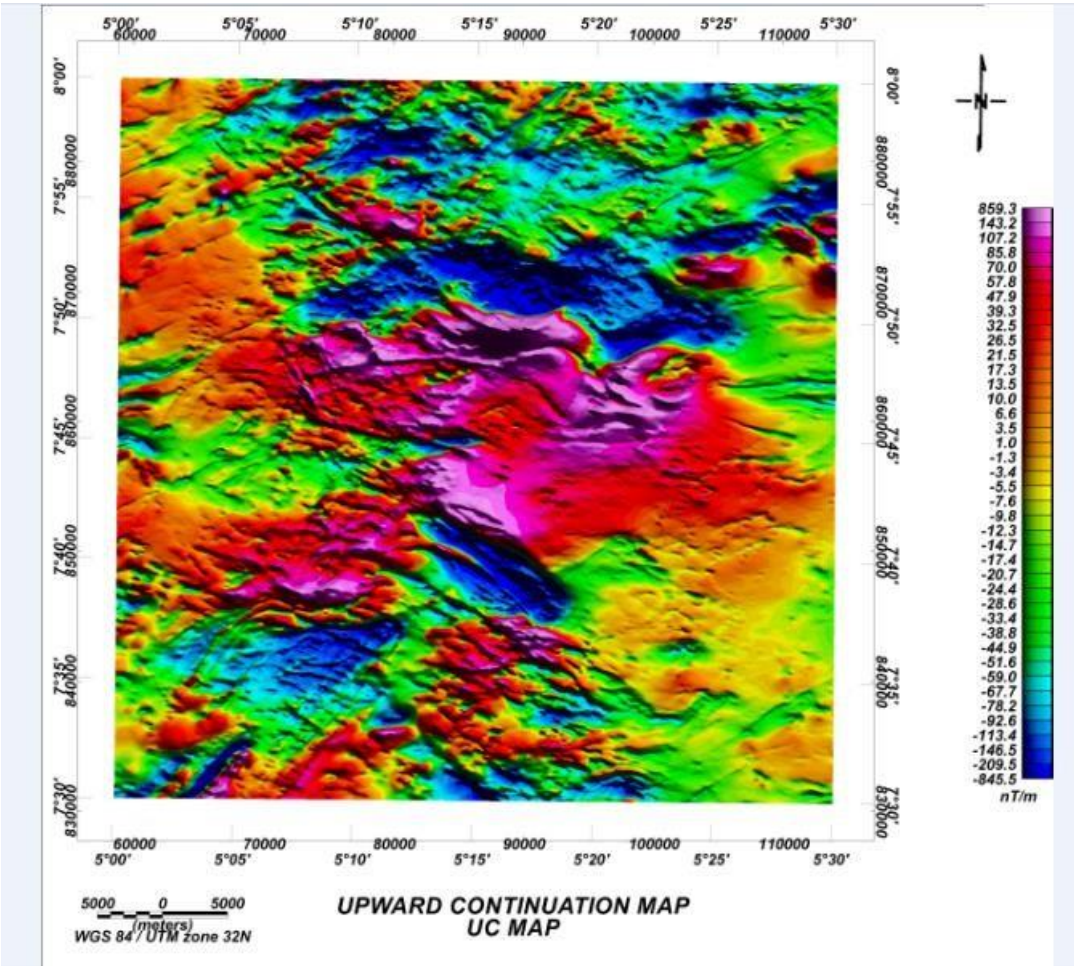

Figure 13: Upward Continuation Map of Ado-Ekiti

Downward Continuation Map

The downward continuation map (Figure 14) enhances the accuracy of the near surface and shallow sources by mathematically extending the field to a lower observation level to produce a range of –1,425.6 nT to +1,151.8 nT. The purple and red hue in the central area is associated with higher positive magnetic anomalies and may represent the presence of magnetic bodies in the subsurface with increased amounts of magnetic minerals, like magnetite (Reeves, 2005). The zones with potential mineral entrapment (intrusions and structurally controlled mineralization) are of particular importance. Low magnetic intensity areas are shown in green to blue colours in the peripheral north and in the north east where the rocks contain low levels of ferromagnetic minerals or a small proportion of these minerals (Blakely, 1995; Telford,1990).

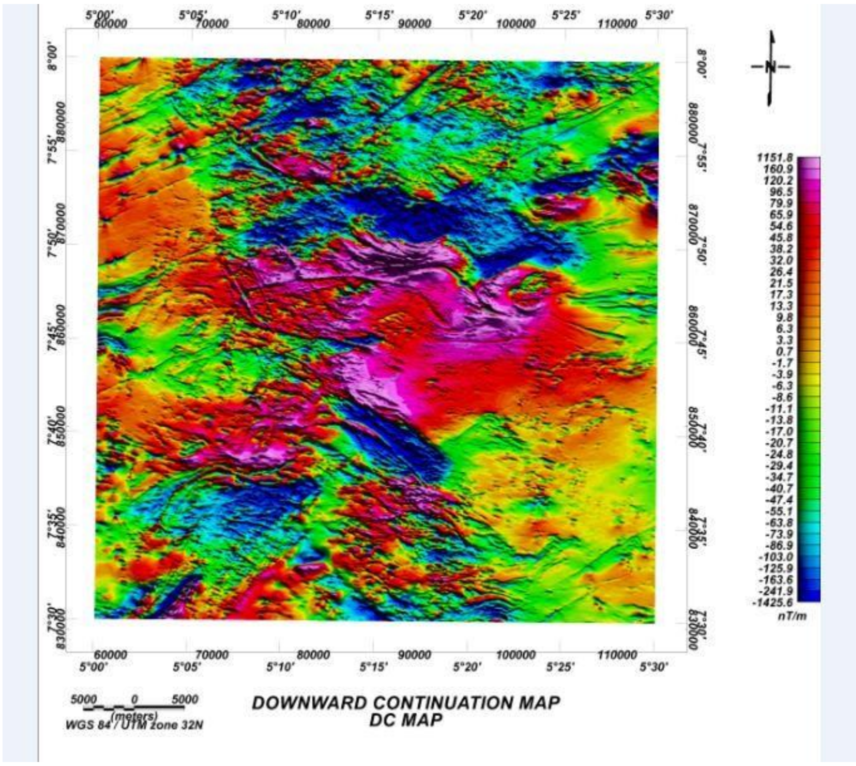

Figure 14: Downward Continuation Map of Ado-Ekiti

3-D Euler Deconvolution: Depth Estimation

The Standard 3-D Euler Deconvolution map (Figure 15) displays the depth distribution and concentration of magnetic sources underneath Ado-Ekiti. Very shallow responses (blue; ~–12 – 75 m), shallow–moderate responses (green; 75 – 129 m), moderate–deep responses (yellow; 129 – 207 m), deep responses (red; 207 – 349 m), and the deepest responses (pink; 349 – 640 m). The depth patterns show the basement structure and indicate areas that may be favorable for mineralization. (Reid et al.,1990, Madeira et al., 2015). The dominance of shallow to moderate solutions (blue and green) over most of the study area reflects the dominant shallow to moderate magnetic sources whose top surfaces are within the upper 130 m which is the known exposure of basement rocks and weathering profile of the Ado-Ekiti terrain (Okpoli and Oladunjoye, 2017).

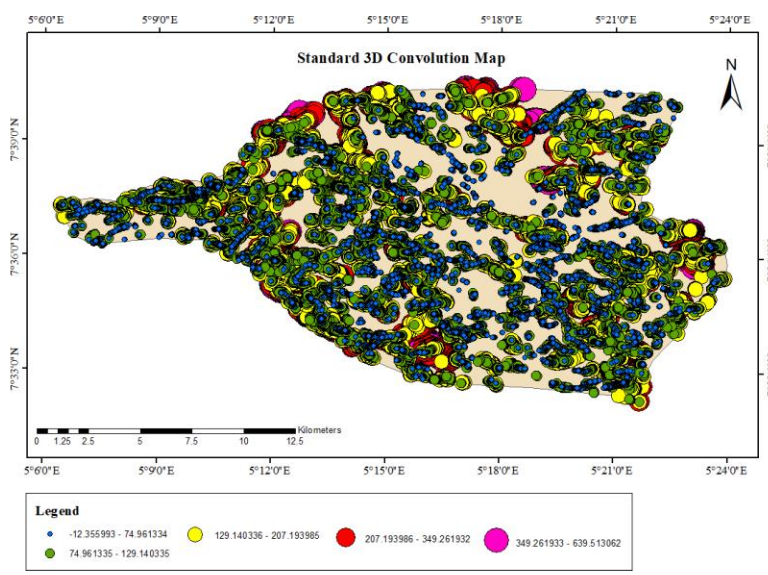

Figure 15: Standard 3-D Euler Deconvolution Map of Ado-Ekiti

The Located 3-D Euler Deconvolution map (Figure 16) offers improved spatial locations and depth measurements for the magnetic source bodies. Depth clusters range from approximately –35 to 27 m (blue), 27–66 m (green), 66–122 m (red), 122–253 m (yellow), and 253–571 m (pink). Deeper solutions (yellow and pink) are concentrated along structural corridors, mainly in the central and northern areas, suggesting fault-controlled structures that penetrate to considerable depths and have the potential to serve as fluid conduits and traps (Okpoli and Oladunjoye, 2017, Blakely,1995, Telford,1990). The linear magnetic features are also associated with clusters of solutions, which supports the hypothesis of the mineralization being fault controlled. The overall distribution of the Euler depth solutions is in the range 100 m to about 1200 m; shallow anomalies (< 300 m) can be associated with near surface lithological contacts and faults in the region, and deep anomalies (> 700 m) are likely associated with intrusive bodies or deeply rooted mineralised zones (Keating and Pilkington, 2004)

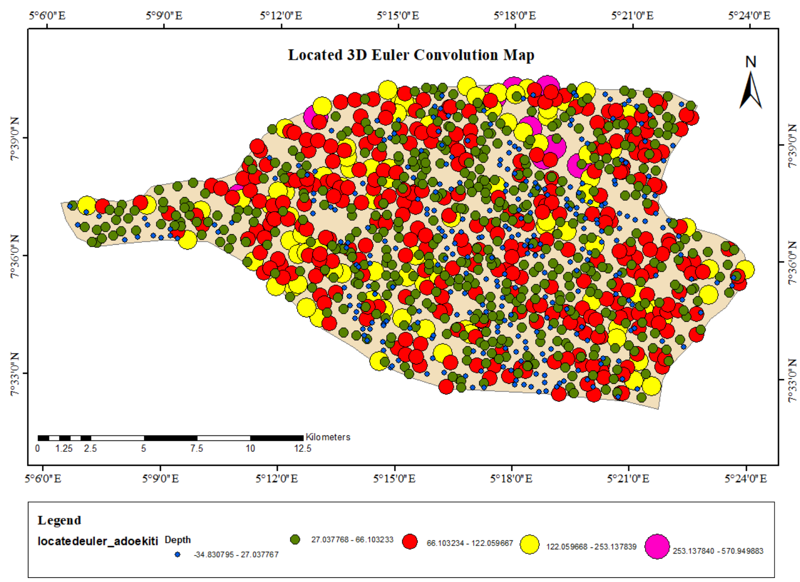

Figure 16: Located 3-D Euler Deconvolution Map of Ado-Ekiti

CONCLUSION

The investigation successfully used airborne magnetic and radiometric datasets to identify structural and geochemical indicators of possible mineral entrapment in Ado-Ekiti. Magnetic analysis revealed major and minor lineaments, faulted zones, and lithological contacts that serve as potential conduits for mineralizing fluids. Depth estimates derived from Euler deconvolution confirmed that several of these structures extend deep enough to influence subsurface fluid movement, with source depths ranging from approximately 100 m to over 1,200 m. Radiometric maps highlighted zones of enhanced radioelement concentrations, marking areas of alteration or compositional change. The consistent alignment between magnetic structures and radiometric anomalies — particularly the correspondence between NE–SW lineaments and K- and U-enriched zones — strengthened the interpretation that these sites possess favourable characteristics for mineral concentration.

The combined datasets identified a number of overlapping magnetic–radiometric anomalies signalling areas where both structural control and surface alteration processes coincide. These zones were outlined as target areas with favourable conditions for possible mineral occurrence. The study demonstrates that combining airborne magnetic and radiometric methods provides an effective and reliable approach for mapping hidden structures and near-surface geochemical variations that influence mineral accumulation within the basement complex of Ado-Ekiti. This study contributes to knowledge by establishing the fact that the spatial overlap of NE–SW and NW–SE structural lineaments with potassium-, thorium- and uranium-enriched areas constitutes a strong geophysical criterion for outlining favourable mineral entrapment areas. Moreover, combining structural mapping with depth estimation can enhance the confidence in the identification of potential subsurface horizons for further exploration. However, study has some limitations because interpretations were mainly based on geophysical signatures and their geological relationship. No detailed field mapping, trenching, drilling, or laboratory geochemical analysis has been done to validate the inferred structural controls, lithological boundaries, hydrothermal alteration zones and mineral entrapment areas. Ground verification is mandatory before mineralization is confirmed, both in terms of its presence, extent and economic importance. It is therefore recommended that exploration activities should be planned with careful regard to settlement patterns, farmland, and community infrastructure within Ado-Ekiti.

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