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## Investigation and Mapping of Uranium, Thorium, and Potassium Mineralization Region Spanning from Isanlu to Egbe Schist belt in Kogi State, North-central Nigeria

\*<sup>1</sup>BUSARI, AO; <sup>2</sup>SULEMAN, KO; <sup>3</sup>BAYOWA, OG; <sup>4</sup>SALAUDEEN, SA; <sup>1</sup>SUNMONU, LA; <sup>5</sup>BAKARE, UT; <sup>6</sup>ABUBAKAR, SA

<sup>\*1</sup>Department of Pure and Applied Physics, Ladoke Akintola University of Technology, Ogbomosho, Oyo State, Nigeria

<sup>2</sup>Department of Physics, School of Basic Sciences, Nigeria Maritime University, Okerenkoko, Delta State, Nigeria

<sup>3</sup>Department of Earth Science, Ladoke Akintola University of Technology, Ogbomosho, Oyo State, Nigeria

<sup>4</sup>Department of Physics, Nile University of Nigeria, Abuja, Nigeria

<sup>5</sup>National Center for Hydropower Research and Development, Jimba-Oja Kwara State, Nigeria

<sup>6</sup>Department of Geological Technology, Federal Polytechnic Offa, Kwara State, Nigeria

\*Corresponding Author Email: [busariabdulrasaq@yahoo.com](mailto:busariabdulrasaq@yahoo.com)

\*ORCID: <https://orcid.org/0009-0001-1435-1763>

\*Tel: +234 8066120632

Co-Author Email: [salaudeen.salaudeen@nileuniversity.edu.ng](mailto:salaudeen.salaudeen@nileuniversity.edu.ng)

**ABSTRACT:** The objective of this paper is to investigate and map the Uranium, Thorium, and Potassium mineralization region spanning from Isanlu to Egbe Schist belt in Kogi State, North Central Nigeria using appropriate standard procedures including high-resolution aeromagnetic and radiometric data which were acquired from the Nigerian Geological Survey Agency (NGSA). The data obtained shows that. Magnetic intensity varies from 56.6 to -45.56 nT. The predominant NNE-SSW orientation of the lineaments suggests that the rocks are of Pan-African age, making up about 95% of the lineaments in the area. Additionally, the NNW-SSE orientation indicates that the tectonic event that deformed the rock units occurred during the Kibaran Orogeny. Overall, the ternary radiometric map reveals significant lithologic diversity and structurally controlled geochemical variations in the study area. Key targets for further exploration include the potassium-rich southern zones, the uranium-associated structural pathways, and areas with mixed radiometric anomalies. Resistivity along all profiles ranges from 52Ω·m to 4,811Ω·m, while Induced Polarization (IP) values vary from 0.00ms to 2,300ms. The anomalous zone exhibits low to moderate resistivity and high chargeability at shallow depths, between 1 and 12 meters across most profiles, indicating potential deposits of tantalum, niobium, and sulfide minerals. An integrated geophysical analysis highlights mineral-rich regions such as Isanlu, Takete, Omi, Idofin, and Egbe, which host valuable minerals including tantalite, columbite, cassiterite, and various sulfide deposits.

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In Nigeria, solid mineral deposits are mostly structurally controlled. They are found in alluvial and eluvial placers, as well as in primary veins across various parts of the supracrustal (Schist) belts in the northwest and southwest (Akiniyi *et al.*, 2020). However, systematic exploration and development

remain limited, resulting in extensive artisanal mining of both primary deposits and their associated alluvial deposits. The metasedimentary rocks of the Egbe-Isanlu-Kabba schist belt are part of numerous NNE-SSW-trending belts mainly composed of low- to medium-grade rocks, predominantly in the greenschist

\*Corresponding Author Email: [busariabdulrasaq@yahoo.com](mailto:busariabdulrasaq@yahoo.com)

\*ORCID: <https://orcid.org/0009-0001-1435-1763>

\*Tel: +234 8066120632

to low-amphibolite facies (Ajadi *et al.*, 2022). This study focused on electrical resistivity, induced polarization, aeromagnetic, and aero radiometric techniques. The aeromagnetic method plays a crucial role in mineral exploration by delineating structures such as faults, folds, contacts, shear zones, and intrusions. It also enables automated detection of porphyry and mineralized zones, which are vital for locating ore deposits (Garba, 2003). Various enhancement techniques can be applied, including Vertical and Horizontal Gradient Magnitude (HGM), Tilt Derivative (TDR), and methods developed by Miller and Singh. Additionally, automated approaches exist to identify porphyry magnetic signatures and delineate lineaments, thereby aiding the recognition of favorable ore-deposit areas. Numerous studies indicate that aeromagnetic data can be interpreted through derivatives (including horizontal, vertical, and total), CET, Euler deconvolution, and 2D Fourier transform (Balogun, 2019; Reid *et al.*, 1990; Ozebo *et al.*, 2015; Lawal *et al.*, 2016; Lawal and Nwankwo, 2017. Olanikanmi *et al.* (2018) conducted a study on the Integrated Geophysical Investigation of structural features beneath Igbetti/Moro in Southwestern Nigeria, highlighting implications for mineral resources and groundwater exploration. They found that the main fault orientations hosting mineral deposits are oriented NE-SW. In my study, additional mineral exploration techniques such as the Induced Polarization method and high-resolution aeromagnetic data will be employed. Ohioma *et al.* (2017) also studied delimited hydrothermally altered zones conducive to gold mineralization in Isanlu, Nigeria, using aero radiometric data. These altered zones,

especially near Odogbe and Okolom in the north-central area, are potential gold sites. Similarly, the zones around Egbe on the western edge are suspected to be mineralized. My research will incorporate other geophysical tools, such as aeromagnetic surveys, to analyze lineament directions and utilize Induced Polarization to gain enhanced insights. Consequently, the objective of this paper is to investigate and map the Uranium, Thorium, and Potassium mineralization region spanning from Isanlu to Egbe Schist belt in Kogi State, North-central Nigeria.

## MATERIALS AND METHODS

**Location and local geology of the study area:** The study area surrounds Isanlu and Egbe, situated within longitude  $5^{\circ} 00'$  to  $6^{\circ} 00'$  East (Eastings 718,400–831,200 mE) and latitude  $8^{\circ} 00'$  to  $9^{\circ} 00'$  North (Northings 883,800–997,900 mN) in Zone 31 of North-central Nigeria (Fig 1). Covering an area of 110 km<sup>2</sup>, it ranges in elevation from 60.57 to 548.87 meters. This region is also part of the Isanlu-Egbe Schist belt. Isanlu – Egbe features eight distinct lithological units, including Banded Iron Formation, Quartzite, Migmatitic Gneiss, Porphyroblastic Gneiss, Coarse Crain Granite, Quartz Diorite, Biotite Schist, and Pegmatite. Petrography analysis shows that Quartz, Plagioclase, Microcline, Biotite, Zircon, Sericite, Orthoclase, and other accessory minerals are the main rock-forming minerals. The primary joint, foliation, and vein directions all align, trending NNE-SSW, with minor variations along NNW-SSE and NWW-SEE, as indicated in the Rose diagram. These features mainly dip eastward (Ajadi *et al.*, 2022).

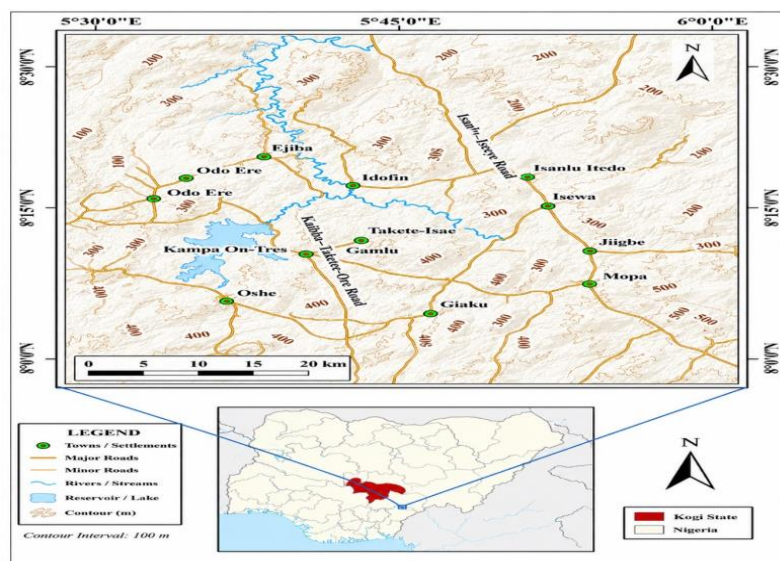


**Fig 1:** Location of the study area within the context of the topographical map of Nigeria.

The research was carried out in two phases: (i) Aeromagnetic and aero radiometric study of the area, and (ii) Integration of Electrical Resistivity methods and Induced Polarization methods.

**Aeromagnetic Method:** This study applies a comprehensive geophysical approach to locate the mineralization zone in the Isanlu-Egbe area. The aeromagnetic data analyzed were obtained from the Nigerian Geological Survey Agency (NGSA) as part of the country's aero geophysical survey program. Data collection involved a fixed-wing aircraft fitted with an airborne magnetometer, flying at low altitude in closely spaced parallel lines to produce high-resolution aeromagnetic data. This data is valuable for mineral exploration, aiding in the identification of regional structures, geothermal sources, and oil and gas targets. The primary software used for processing and enhancing the data is Oasis Montaj, which filters the data and executes advanced models such as the analytical signal, Reduce to Equator, and Euler deconvolution. This approach effectively determines the orientation of regional faults that could host mineral deposits, even in rugged terrain and difficult-to-access areas. Magnetometers may also use a variety of different sensor types. Proton magnetometers have largely been superseded by faster and more sensitive fluxgate and cesium instruments. The software used to analyze the collected data is Oasis Montaj, and the Enhancement procedures are discussed below, which align with the work of Ajadi *et al.* (2022).

**The euler deconvolution techniques (edt):** The EDT method is used to find, describe, and measure the depth of magnetic sources in potential-field data, whether in profiles or grids. Unlike more complex methods, such as the Continuous Wavelet Transform, which can operate without prior geometric data (Chamoli *et al.*, 2006), EDT relies on minimal geometric information via structural indices. It is based on the Euler 3D homogeneity equation, which is related to magnetic field data (Reid *et al.*, 1990).

$$\frac{X\partial T}{\partial x} + \frac{Y\partial T}{\partial y} + \frac{Z\partial T}{\partial z} + \eta T + \frac{X_0\partial T}{\partial x} + \frac{Y_0\partial T}{\partial y} + \frac{Z_0\partial T}{\partial z} + \eta b \quad (1)$$

$z_0$  represents the position of a magnetic source, and the total magnetic field anomaly at the coordinate (x, y, z) is denoted by M.  $\beta$  denotes the regional magnetic field component. At the same time,  $\eta$ , known as the structural index [S.I.], quantifies how quickly the field changes with distance. The S.I varies for different types of anomalous bodies: S.I = 0.0 signifies a magnetic contact or thick step; S.I = 1.0 corresponds to sills or dykes; S.I = 2.0 indicates a homogeneous cylinder or pipe; and S.I = 3.0 represents spheres.

**The tilt derivatives and total horizontal derivatives:** The THD has been used to define the boundaries and horizontal extent of anomalous source bodies (Chamoli *et al.*, 2006). It offers a simple way to identify the contact points of linear and continuous magnetic sources. The THD formula is provided in Equation 2.

$$THDR = \sqrt{\left(\frac{\partial T}{\partial x}\right)^2 + \left(\frac{\partial T}{\partial y}\right)^2} \quad (2)$$

To obtain structural features, the maximum values aligned linearly can be interpreted as lithologic contrast and faults. Also, when the derivative attains a maximum at locations where magnetic susceptibility is greatest and highlights magnetic discontinuities perpendicular to the direction of derivation, it indicates the edges of geological structures (Salawu *et al.*, 2019).

**Aero radiometric method:** Aero radiometric data purchased from the NGSA (Nigeria Geological Survey Agency) were used to delineate geological boundaries and identify highly mineralized zones within Isanlu Egbe. The delineation was based on gamma-ray emissions from uranium, thorium, and potassium in the soil. This potential mineralized zone, determined through interpretation of the aero-radiometric map, and the likely structural features that could host economically viable minerals. Oasis Montaj software was used to analyze the four datasets (Thorium, Uranium, Potassium, and ternary). The aero-radiometric data were used to delineate lithologic boundaries and identify areas of hydrothermal alteration that may host economic minerals, such as tantalite, cassiterite, and other Rare Earth Metals, within Isanlu Egbe. The ternary radiometric map of potassium (K), thorium (Th), and uranium (U) provides insight into the lithological variation and alteration patterns within the study area. The RGB composite assigns potassium to red, thorium to green, and uranium to blue, thereby enabling discrimination of different rock units and geochemical domains based on their radiometric signatures.

**Electrical resistivity techniques and the induced polarization method:** This study used the Wenner-alpha array (Fig 2) for electrical resistivity measurements, combined with the Induced Polarization method. The main field instrument was the Er System, which digitally displays apparent resistivity and chargeability readings. It runs on a 12-V DC power supply. Additional accessories included twenty-one metal electrodes, cables for current and potential measurements, four harmers, measuring

tapes, and writing pads. In the field setup, electrodes are symmetrically arranged along a straight line, with outer current electrodes and inner potential electrodes, all spaced at a fixed distance "a." To modify the measurement depth, the current and potential electrodes are moved outward together. During fieldwork, the resistivity meter automatically records voltage and current, processes the data, calculates resistance in real time, and displays the results on a digital screen. The collected data were analyzed using RES2DINVERSION Software to generate a 2D image.

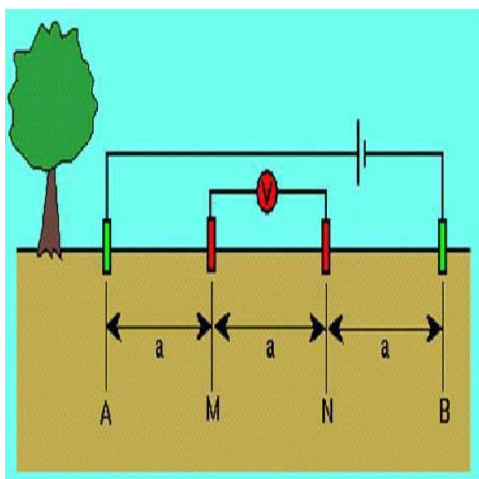


Fig 2: A typical wenner alpha electrode configuration

## RESULTS AND DISCUSSION

**High resolution aeromagnetic map interpretation:** The maximum positive magnetic anomaly ranges from 57.67 to the minimum of -67.64 nT deduced from the RTE map (Fig 3). The difference between the highest and lowest magnetic intensities is 124 nT, suggesting that most rocks in the area are weakly magnetized. These rocks are mainly metasedimentary, metavolcanic, and migmatite groups, originating from acidic igneous or sedimentary rocks. In the northeastern part, rocks with high magnetic intensity are likely due to basic igneous or metavolcanic rocks such as diorite, amphibolite, and basic dykes, identified as Zone A. Conversely, the southwestern regions, including Takete, Ojuku, and Ijowa, exhibit rocks with negative magnetic signals, such as phyllites, quartzites, and schists, marked as Zone C on the signal map. The intermediate magnetic group is represented by migmatites, including Augen gneiss, migmatitic gneiss, and porphyroblastic gneiss, and is commonly found around Takete, Egbe, and Ijowa, and is labeled Zone C (Figure 4). Some linear and curved structures, marked by strong positive magnetic anomalies in the southern part of the studied sheets,

suggest the presence of basic dykes intruding the metasedimentary rocks.

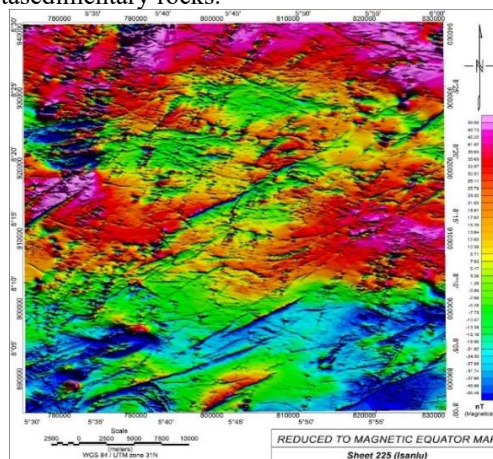


Fig 3: Image showing reduced to magnetic equator map of Isanlu sheet 225

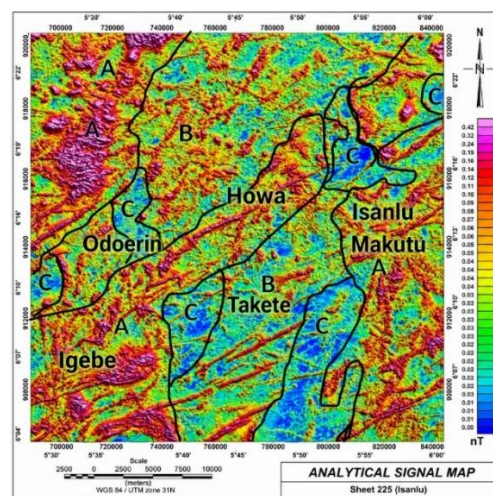


Fig 4- Image showing interpreted analytical signal map

The First Vertical Derivatives map shows that 90% of the subsurface lineaments in the studied sheet trend NE-SW and align with Pan-African-age rocks. About 7% trend NW-SE, corresponding to Kibaran-age rocks, and another 3% trend E-W, matching Liberian-age rocks. These orientations are clearly shown in the Rose diagram derived from the map (Fig 5). The Euler Deconvolution Map (Figure 6) shows that the deepest magnetic sources, located 2.5-4.5 km below the surface and represented by blue to green colors, are concentrated in the western part of the study area. Furthermore, shallow- to intermediate-depth magnetic sources, ranging from 1 m to 2.5 km and represented by yellow, red, and pink colors, are well distributed in the western part of the study area. The study area exhibits a structurally complex setting characterized by multiple fault and lineament systems. Shallow magnetic sources dominate along these lineaments, suggesting the presence of near-surface geological

bodies such as dykes, sills, or lithological contacts. These features indicate zones of structural weakness that may have facilitated magmatic intrusion and fluid movement. In contrast, deeper magnetic sources identified in the central and south-central parts of the area indicate the presence of buried intrusive bodies or deep-seated geological structures. These deeper anomalies are significant as they may represent the roots of magmatic systems or zones of enhanced mineralization potential.

*Aero radiometric map interpretation:* The Uranium, Thorium, and Potassium maps were interpreted visually to characterize lithology, delineate possible alteration zones, and identify the mineralized zone within the study area.

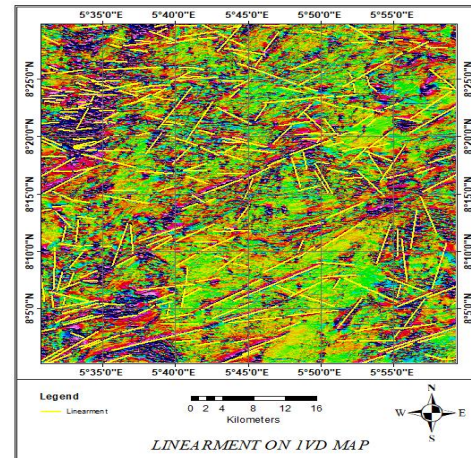


Fig 5: Image showing lineaments on the second vertical derivatives map

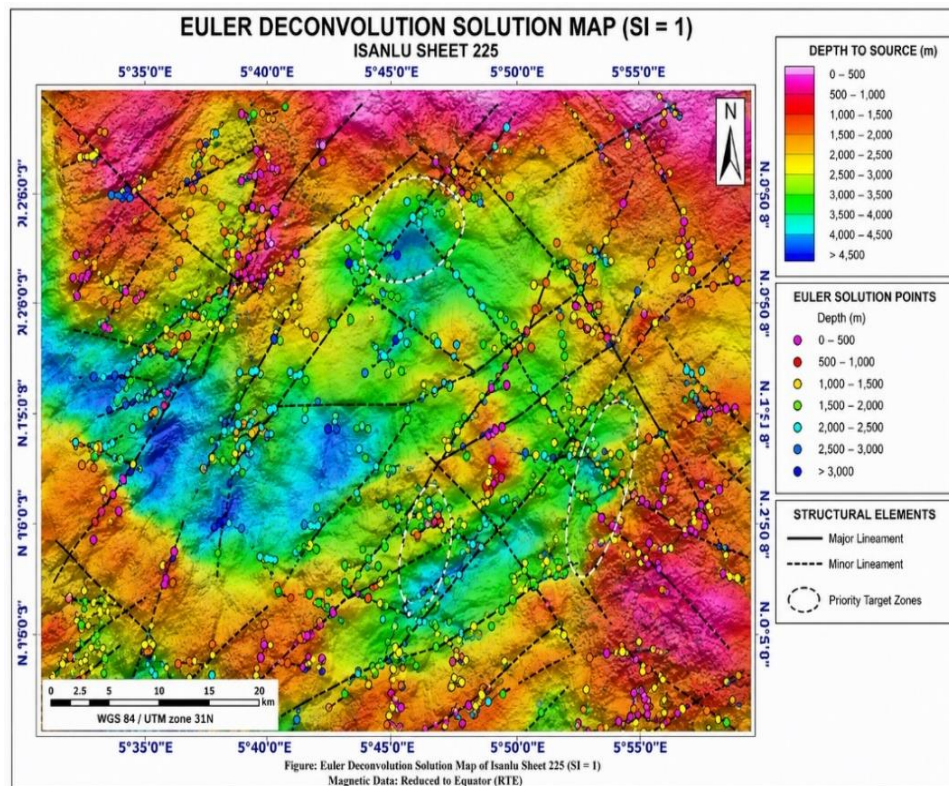


Fig 6: Euler Deconvolution map of Isanlu Egbe Sheet 225

*Potassium (K):* The color blue indicates low K values, labeled "LP," while pink indicates very high K values, labeled "HP." Additionally, the color red signifies moderately high to high K values, also labeled as "IK" as well, and the shades of green to yellow represent moderate "K" values. There is a high concentration of K around the S, SE, and NE parts of the study area, which fall within the Takete, Egbe, Ijowa, and Ejiba areas (Fig 7). Field geological mapping also shows that these areas are highly enriched in felsic igneous

rocks, including granite and complex pegmatite veins that host tantalum, beryllium, and cassiterite ores. An intermediate K concentration is also observed along the extreme edge of the NW part of the study area, indicating the presence of rocks with moderate K concentrations. There is a very low concentration of K in the central part of the study area, indicating the presence of K-depleted rocks such as diorite and dolerite dykes, with other hydrothermal veins around

the Okolom area, which corresponds with the work of Ohioma *et al.* (2017).

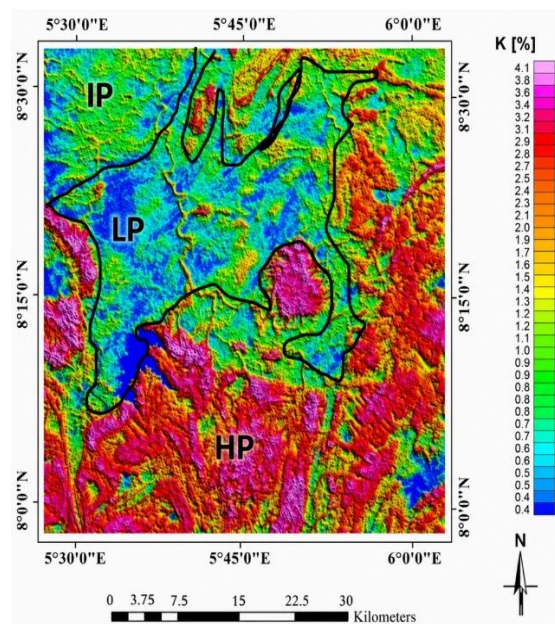


Fig 7: Image showing potassium (k) concentration map

**Thorium:** The color blue corresponds with low Th values denoted by "LTh", while the pink and red correspond with very high Th values denoted by "HTh" as well, and the shades of green to yellow color represent moderate "MTh" values (Fig 8). Thorium is concentrated in felsic-rich, acidic igneous rocks such as granite, pegmatite, and aplite, as well as in hydrothermal deposits, which are often associated with monazite and other heavy minerals. The rocks are stable, and the heavy minerals remain in place because thorium is stable and immobile, unlike potassium. Thus, thorium is a good indicator for distinguishing rock types and for mineral exploration. A high concentration of Th is observed around the N-S part of the study area, which falls under the Takete, Ijowa, Okolom, and Ejiba areas. Intermediate Th concentrations are also observed at the extreme edge of the studied sheet. Thorium enrichment, commonly associated with resistant minerals such as monazite and zircon, suggests relatively stable and less altered lithologies. These zones are scattered across the central and northern parts of the study area, indicating variations in rock composition and weathering intensity.

**2D Resistivity and Chargeability image interpretation for profile 3:** The Idofin area is known for high tantalite yields from both primary and secondary deposits. The region features extensive NE-SW-trending pegmatite rock formations. In the resistivity map, blue, green, yellow, and purple indicate low,

intermediate, and high resistivity levels, respectively. Similarly, in the chargeability map, blue, green, yellow, and red represent low, intermediate, and high chargeability values. The underlined area consists of extensive pegmatite rock extending in a NE-SW direction, hosted by Granitic Gneiss and Migmatitic Gneiss. The site is an active mine with very shallow overburden. Resistivity values range from  $204\Omega\text{m}$  to  $2,083\Omega\text{m}$ , and Induced Polarization (IP) values range from 91.2ms to 637ms. The survey profile is 115 meters long, with an average depth of 12 meters, using a Wenner array. An anomalous zone characterized by low to moderate resistivity and high chargeability appears between 1 and 4 meters in depth, with resistivity of  $240\Omega\text{m}$  and IP of 620ms along a profile length of 1 to 16 meters (Fig 13). This suggests the presence of tantalum, niobium, and other sulfide mineralization.

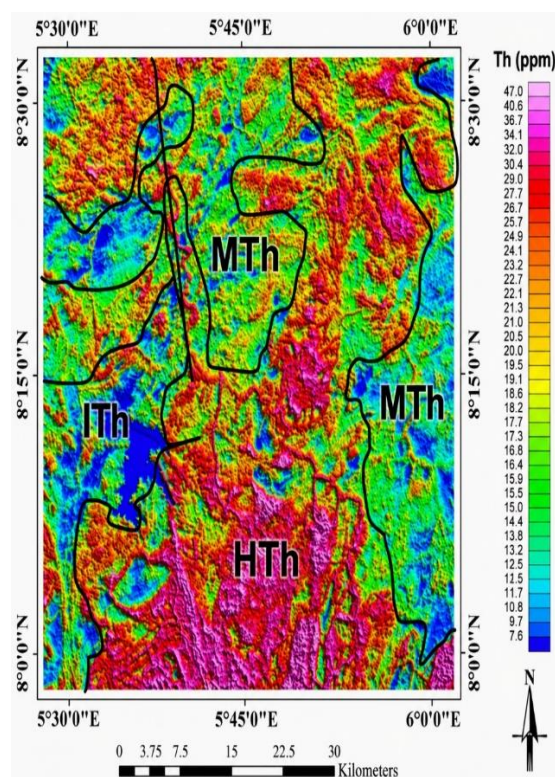


Fig 8: Image showing Thorium (Th) concentration map

**Uranium:** The color blue indicates low U values, labeled "LU," while pink and red indicate very high U values, labeled "HTh." Shades of green to yellow depict moderate U values. High uranium concentrations are observed in the northern and central parts of the study area (Fig 9). Additionally, sharp alteration zones, evident in the northeastern region, trend NE-SW. Uranium enrichment is often associated with fluid pathways, fractures, or zones of alteration. The presence of uranium anomalies, especially when

they coincide with structural features, suggests possible hydrothermal activity and enhanced subsurface permeability.

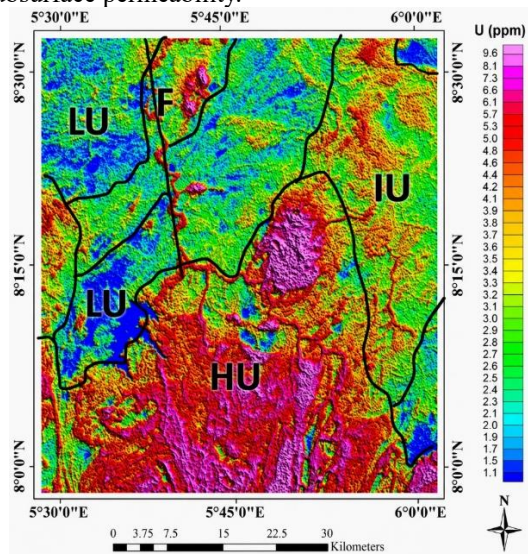


Fig 9: Image showing Uranium (U) concentration map

**Ternary:** The superimposed structural boundaries highlight the control of geological structures on radiometric distribution. Lineaments and structural trends appear to influence the localization of radiometric anomalies, suggesting that these structures may have acted as conduits for fluid migration and mineral deposition. Black areas show low levels of uranium, thorium, and potassium. Magenta highlights zones with high potassium but low uranium and thorium. Yellow marks regions with high potassium and thorium, but low uranium. Green indicates rocks with low potassium but high uranium and thorium. White signifies zones with high levels of all three elements: uranium, potassium, and thorium. Black also represents areas with low concentrations of all three. Blue identifies regions with high uranium but low thorium and potassium (Fig 10). White-colored regions are located around the mid-southern part of the study area, indicating zones with granite and pegmatite dykes (Adepelumi and Falade, 2017). These include Isanlu, Takete, Ijowa, and Idofin. Areas displaying high concentrations of uranium and thorium with low potassium, marked in green, are located in the northeast and north parts of the study

**2D Resistivity and Chargeability image interpretation for profile 3:** The Idofin area is known for high tantalite yields from both primary and secondary deposits. The region features extensive NE-SW-trending pegmatite rock formations. In the resistivity map, blue, green, yellow, and purple indicate low, intermediate, and high resistivity levels, respectively. Similarly, in the chargeability map, blue, green,

area and represent granite and syenite suites (Adepelumi and Falade, 2017). Regions with low levels of potassium, uranium, and thorium, covering less than 5% of the total area, suggest the presence of carbonate and silicate formations and Quaternary sediments (AKiniyi et al., 2010). Magenta-colored regions indicating low thorium and uranium but high potassium denote hydrothermal deposits, clearly observed in the east and west parts of the study area. Of particular significance are zones where mixed colors (e.g., white, cyan, or magenta) occur, indicating the coexistence of potassium, thorium, and uranium. These mixed signatures may represent zones of intense alteration, complex lithological contacts, or areas with high mineralization potential. Overall, the ternary radiometric map indicates that the study area exhibits significant lithologic diversity and structurally controlled geochemical variations. The potassium-rich southern zones, the uranium-associated structural pathway, and mixed radiometric anomalies are key targets for further investigation. These areas are prioritized for detailed geophysical surveys to assess their mineralization potential.

**2D Resistivity and Chargeability image interpretation for profile 2:** The profile is located near the Omi and Oga area, surrounded by the Omi Dam (Fig 12). The area is underlain by extensive pegmatite rock, oriented NE-SW, and hosted by Granitic Gneiss. In the resistivity image, blue, green, yellow, and red represent low, intermediate, and high resistivity values, respectively. In the chargeability image, blue, green, yellow, and red indicate low, intermediate, and high chargeability values, respectively. The resistivity values range from 131  $\Omega\text{m}$  to 1,663  $\Omega\text{m}$ , while the Induced Polarization values span from 12.7 ms to 473ms. The profile length is 100 meters, with a depth of 12 meters, using the Wenner array. An anomalous zone characterized by low resistivity and high chargeability is observed between 1- and 8-meters depth, with resistivity and IP values of 183  $\Omega\text{m}$  and 2,300ms, respectively, along profile sections between 15 and 40 meters. This suggests the presence of tantalum, niobium, and other sulfide mineralization in the study area. Additionally, lithium ore is mined along the profile line, exhibiting anomalous concentrations over a 94-meter stretch.

yellow, and red represent low, intermediate, and high chargeability values. The underlined area consists of extensive pegmatite rock extending in a NE-SW direction, hosted by Granitic Gneiss and Migmatitic Gneiss. The site is an active mine with very shallow overburden. Resistivity values range from 204 $\Omega\text{m}$  to 2,083 $\Omega\text{m}$ , and Induced Polarization (IP) values range from 91.2ms to 637ms. The survey profile is 115 meters long, with an average depth of 12 meters, using

a Wenner array. An anomalous zone characterized by low to moderate resistivity and high chargeability appears between 1 and 4 meters in depth, with resistivity of 240  $\Omega$ m and IP of 620ms along a profile length of 1 to 16 meters (Fig 13). This suggests the presence of tantalum, niobium, and other sulfide mineralization.

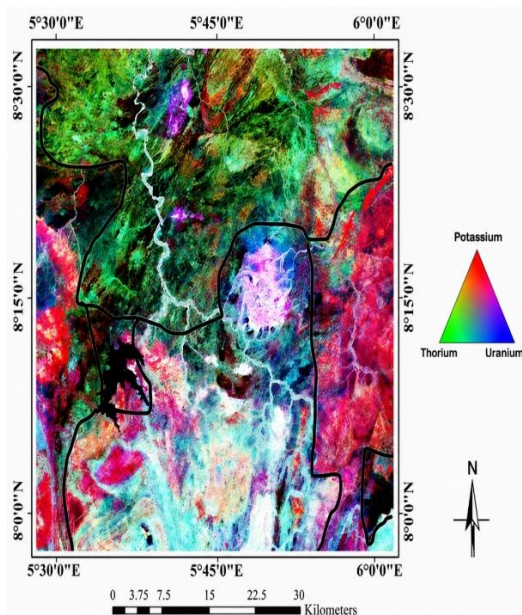


Fig 10: Image showing a ternary map of Isanlu sheet 225

*Electrical resistivity techniques (ert) and induced polarization method:* This subheading discusses the

interpretation of electrical resistivity and Induced Polarization data collected across different parts of the study area to identify mineralized zones and their corresponding depths. The profile lines were selected from the study area by overlaying the linear density map from the aeromagnetic survey onto the ternary map derived from the aero-radiometric map of Isanlu, which helps identify the structural pathways that mineralization fluids may follow.

*2d resistivity and chargeability image interpretation for profile:* The profile is situated near Ijowa in the Isanlu Local Government Area. The area is underlain by pegmatite rock extending in a NE-SW direction, embedded within coarse-grained granite. The profile line runs along the N-S direction. In the resistivity image, blue, green, yellow, and red represent low, intermediate, and high resistivity values, respectively. In the chargeability image, blue, green, yellow, and red indicate low, intermediate, and high chargeability values, respectively. Resistivity values range from 66.8 $\Omega$ m to 881 $\Omega$ m, while Induced Polarization (IP) values vary from 7.78mV to 491ms (Fig 11). An anomalous zone is observed at a depth of 2 meters, with low to moderate resistivity and high chargeability, yielding resistivity and IP readings of 6.76  $\Omega$ m and 780ms, respectively. This zone extends along a profile length of 14-43 meters and indicates potential mineralization of tantalum, niobium, and other sulfides between 14 and 42 meters within the study area.

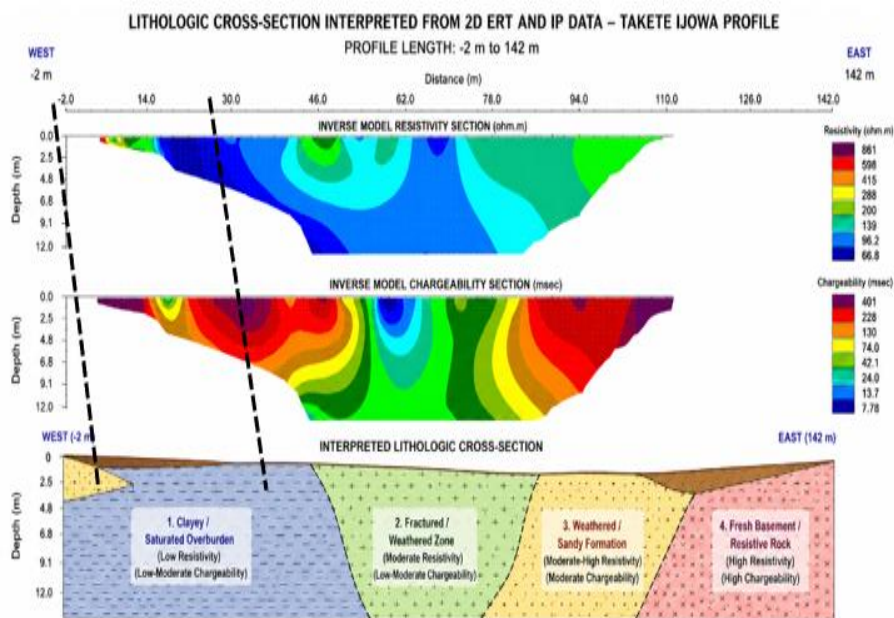


Fig 11: 2d electrical resistivity and induced polarization image along profile 1 (n08° 12' 2.3 e005° 49' 41.97").

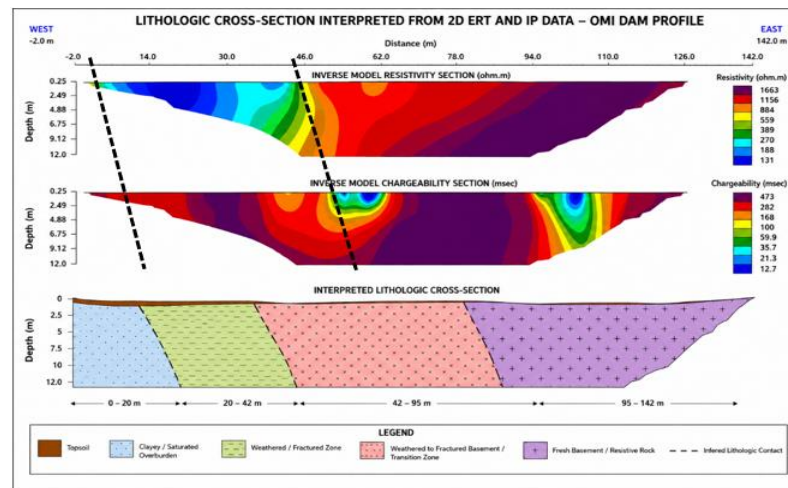


Fig 12: 2d resistivity and chargeability image along profile 2 (n08° 14' 52.7 e005° 39' 44.45")

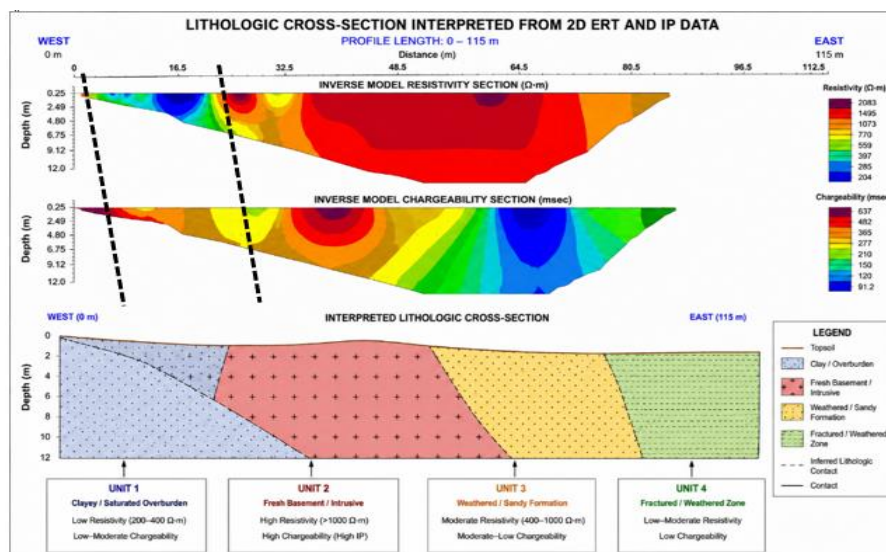


Fig 13: 2d pseudo section along profile 4 (n08° 16' 7.01 e005° 45' 13.40")

**Conclusion:** This research investigated and mapped the Uranium, Thorium, and Potassium mineralization region spanning from Isanlu to Egbe Schist belt in Kogi State, North-central Nigeria. The dominant NNE-SSW orientation of the lineaments indicates that the rocks are Pan-African in age. In addition, the NNW-SSE orientation indicates that the tectonic event that deformed the rock units occurred during the Kibaran Orogeny. This is also consistent with the KZI (Kazauri Zuru Ifewara) regional fault. Most rocks in the area are weakly magnetized which mainly consist of metasedimentary, metavolcanic, and migmatite groups of acid igneous or sedimentary origin. The northeastern part features rocks with high magnetic intensity, possibly due to the presence of basic igneous or metavolcanic rocks, such as diorite, amphibolite, and basic dykes. Low levels of Potassium, Uranium, and Thorium are common in some part of Isanlu and

Egbe. Regions with low Th and U but high K, marked in magenta, indicate hydrothermal deposits, mainly located in the eastern and western parts of the study area. Additionally, areas with high U and low Th and K, indicating uranium-enriched zones identified through ternary map are also common within the study area. An integrated geophysical study indicates that areas such as Isanlu, Takete, Omi, Idofin, and Egbe are rich in valuable minerals, including tantalite, columbite, cassiterite, and other sulfide minerals.

## DECLARATIONS

**Ethical Approval:** This study did not involve human participants or animal experimentation and therefore did not require formal ethical approval. All procedures involving data handling and analysis were conducted responsibly and in accordance with standard academic and institutional.

BUSARI, A. O; SULAIMAN, K. O; BAYOWA, G. O; SALAUDEEN, T. A; SUNMONU, L. A; BAKARE, U. T; ABUBAKAR, S. A

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**Declaration of Conflict of Interest:** The authors declare that no known conflict of interest or personal relationships that have influence the work reported in this paper (if none).

**Declaration of Data Availability Statement:** The data that are used in this research are available upon request from the corresponding author.

## REFERENCES

- Akinniyi, AO; Nguyen, DC; Wojas, AT; Tomecka, SS; (2020). Characterization of lithological zones of the Isanlu sheet 225, North Central Nigeria, using aerogeophysical datasets. *J. Geophysical Sci.* 68:651–665. <https://doi.org/10.1007/s11600-020-00411-6>
- Ajadi, JO; Busari, AO; Babatund, AS; (2022). Mineralogy, Geochemistry, and Economic Potentials of Pegmatites around Egbe-Ejiba Isanlu, Isanlu Sheet 225, Southwestern, Nigeria. *Nig. J. Afr. Earth Sci.* 4: pp. 109–114 <https://doi.org/10.1327/s11600-064-02311-8>
- Adepelumi, AA; Falade, AH; (2017). Combined high-resolution aeromagnetic and radiometric mapping of uranium mineralization and tectonic settings in Northeastern Nigeria. *Acta Geophysica*, 65, 1043–1068. <https://doi.org/10.1007/s11600-017-0080-3>
- Balogun, OB; (2019). Tectonic and structural analysis of the Migmatite–Gneiss–Quartzite complex of Ilorin area from aeromagnetic data. *NRIAG J. Astro. Geophy.* 8(1), 22–33. <https://doi.org/10.1080/20909977.2019.1615795>
- Chamoli, AB; Dimri, VP; Bansal, AR; (2006). Wavelet and rescaled range approach for the Hurst coefficient for short and long time series. *Computers and Geosci.*, 33(1), 83–93. <https://doi.org/10.1016/j.cageo.2006.05.008>
- Garba I (2003). Geochemical characteristics of mesothermal gold mineralization in the Pan-African basement of Nigeria. *Trans Inst Min Metall* 112(3):123–135. <https://doi.org/10.1179/037174503225003143>
- Lawal, TO; Salawu, NB., Orosun, MM Ekpumoh, JI; Nwankwo, LI; (2016). Application of 3-D Euler deconvolution technique to aeromagnetic data of Ilorin and Osi, Northcentral Nigeria. *Zimbabwe J. Sci. Tech.* 11(1), 66–75. <https://doi.org/10.1016/j.jafrearsci.2015.10.015>
- Lawal, TO; Nwankwo, LI; (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. *Arabian J. Geosci.* 10, Article 378. <https://doi.org/10.1007/s12517-017-3154-2>
- Ohioma, JO; Ezomo, FO; Akinsunmade, A. (2017). Delineation of hydrothermally altered zones that favour gold mineralization in Isanlu area, Nigeria using aeroradiometric data. *Inter. j. Sci.* 2(1), 20–27. <https://doi.org/10.21467/ias.2.1.20-27>
- Olasunkanmi, NK; Sunmonu, LA; Adabanija, MA; Oladejo, OP; (2018). Interpretation of high-resolution aeromagnetic data for mineral prospect in Igbe-Moro area, Southwestern Nigeria. *IOP Conference Series: Earth and Environmental Science*, 173, 012033. <https://doi.org/10.1088/1755-1315/173/1/012033>
- Ozebo, V.C; Ogunkoya, CO; Makinde, V; Omeike, MO; (2015). An estimation of magnetic contact location and depth of magnetic sources in Ilesha, Nigeria, using magnetic gradient techniques. *African Review of Physics*, 10, 17–26. <https://doi.org/10.1179/037632032250031433>
- Salawu, NB; Fatoba, JO; Adebisi LS; Dada, SS; (2021). New insights on the Ife-Ilesha schist belt using integrated satellite, aeromagnetic, and radiometric data. *Sci Rep* 11:15314. <https://doi.org/10.1038/s41598-021-94813-1>