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Assessment of gold mineralization potential using aeromagnetic and Aeroradiometric data in Dagbala Edo North, Nigeria

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Abstract

This study investigates the potential for gold mineralization in Dangbala and its environs in Edo North, Nigeria. By integrating aeromagnetic and aeroradiometric data, the research aims to map lithological and structural features associated with mineral deposits, particularly gold. The study highlights the importance of airborne geophysical methods in mineral exploration, offering insights into the geological structures that host these minerals. The findings provide a basis for further exploration and the economic assessment of mineral deposits in the region.

Keywords: Gold Mineralization; Aeromagnetic Data; Aeroradiometric Data; Lineament Analysis; Hydrothermal Alteration

1. Introduction

The use of geophysical methods, such as magnetic, gravity, and gamma-ray spectrometry, is vital in exploring mineral deposits in areas with complex geological structures. This study focuses on Dangbala, an area with significant untapped gold reserves. The research uses aeromagnetic and aeroradiometric data to identify gold-bearing structures and hydrothermal alteration zones, key indicators of mineralization. The study emphasizes the socio-economic impact of mineral exploitation, highlighting its potential to reduce unemployment and boost local economies.

1.1. Study area

The study area, located in Edo State, southwestern Nigeria, covers approximately 8,100 km^2 and lies within the basement complex hosting the Igarra Schist Belt. The geology includes diverse rock types such as coal, sandstone, shale, granite, gneiss, migmatite, and quartzite. The region is part of the Pan-African mobile belt and has undergone four major orogenic cycles: Liberian, Eburnean, Kibaran, and Pan-African, leading to deformation and metamorphism.

Four key geological units are present

- Migmatite-Gneiss Complex
- Schist Belt
- Older Granites
- Undeformed Acid and Basic Dykes

The Igarra Schist Belt, along with the Oba and Ibillo belts, is characterized by varied lithology, including conglomeratic sandstone, schist, lignite, claystone, and formations like the Mamu Formation.

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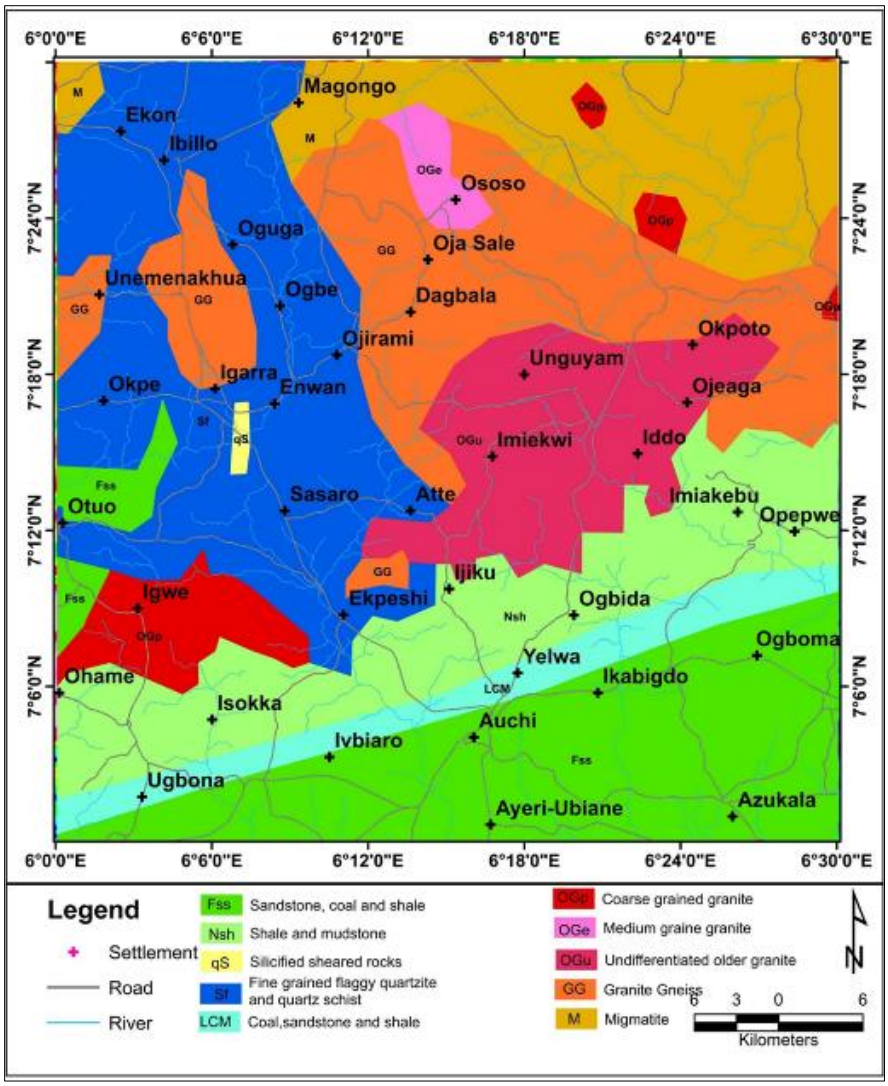

Figure 1 Location and Geologic Map of the Study area (Adapted from NGSA, 2006)

2. Materials and Methods

Aeromagnetic and aeroradiometric data were obtained from the Nigerian Geological Survey Agency (NGSA). The data covered two sheets (OWO and AUCHI) and were processed using Oasis Montaj software. The analysis involved generating composite maps of the study area, removing geomagnetic gradients, and inspecting various magnetic and radiometric maps to identify geological anomalies indicative of gold mineralization.

3. Results and discussion

The study focuses on analyzing airborne magnetic and radiometric data over parts of Edo North and its surroundings to identify subsurface structures and mineral potential zones. Several digital filters were applied to enhance and interpret the data both qualitatively and quantitatively.

- Lineament Mapping: The area, predominantly basement in the north and sedimentary in the south, is dissected by lineaments trending EW, NE-SW, and ENE-WSW. These lineaments, mapped using CET lineament analysis, are potential veins hosting minerals.
- Analytic Signal Analysis: This was performed to define source boundaries and mineralized lineaments. The analytic signal map shows high amplitudes (0.109 - 0.233 nT/m) in areas with magnetic minerals, such as tin, iron, zinc-lead ores, and gold, especially where lineaments overlap with high analytic signal zones.
- Distance to River Map: Mineral occurrences, mapped using gold detection machines, are found to be in proximity to rivers, as shown in Figure 1.

- Depth to Magnetic Source: Depths to magnetic sources range from 3.32 m to 1764 m. Shallow depths (3.32 m - 130 m) are typical of mineralized veins in the basement areas (Dangbala, Ojah).
- Hydrothermal Alteration: Hydrothermal alteration zones, with values above 0.2 %/ppm, indicating potassic specialization, are associated with mineralization. These zones are predominantly around areas like Igwe, Ikpeshi, Imiekwi, Otuo, and Dagbala. Overlaying the magnetic lineaments shows structural associations, confirming that hydrothermal fluids have altered and mineralized the rocks in these areas.
- Geology and Hydrothermal Alteration: Granitic rocks (porphyritic and undifferentiated granite) are the most affected by hydrothermal alteration, followed by granite gneiss, schist, and adjacent shale and mudstone. These rocks host mineralization, confirming the importance of hydrothermal zones in mineral deposits.

The aeroradiometric maps allowed for the correlation between radioactivity and rock units, aiding in the identification of hydrothermal alteration zones. The study demonstrated that the NE-SW trending structures were the most favorable for gold deposits. Additionally, the findings suggest that further exploration and drilling in identified zones could lead to economically viable mining operations.

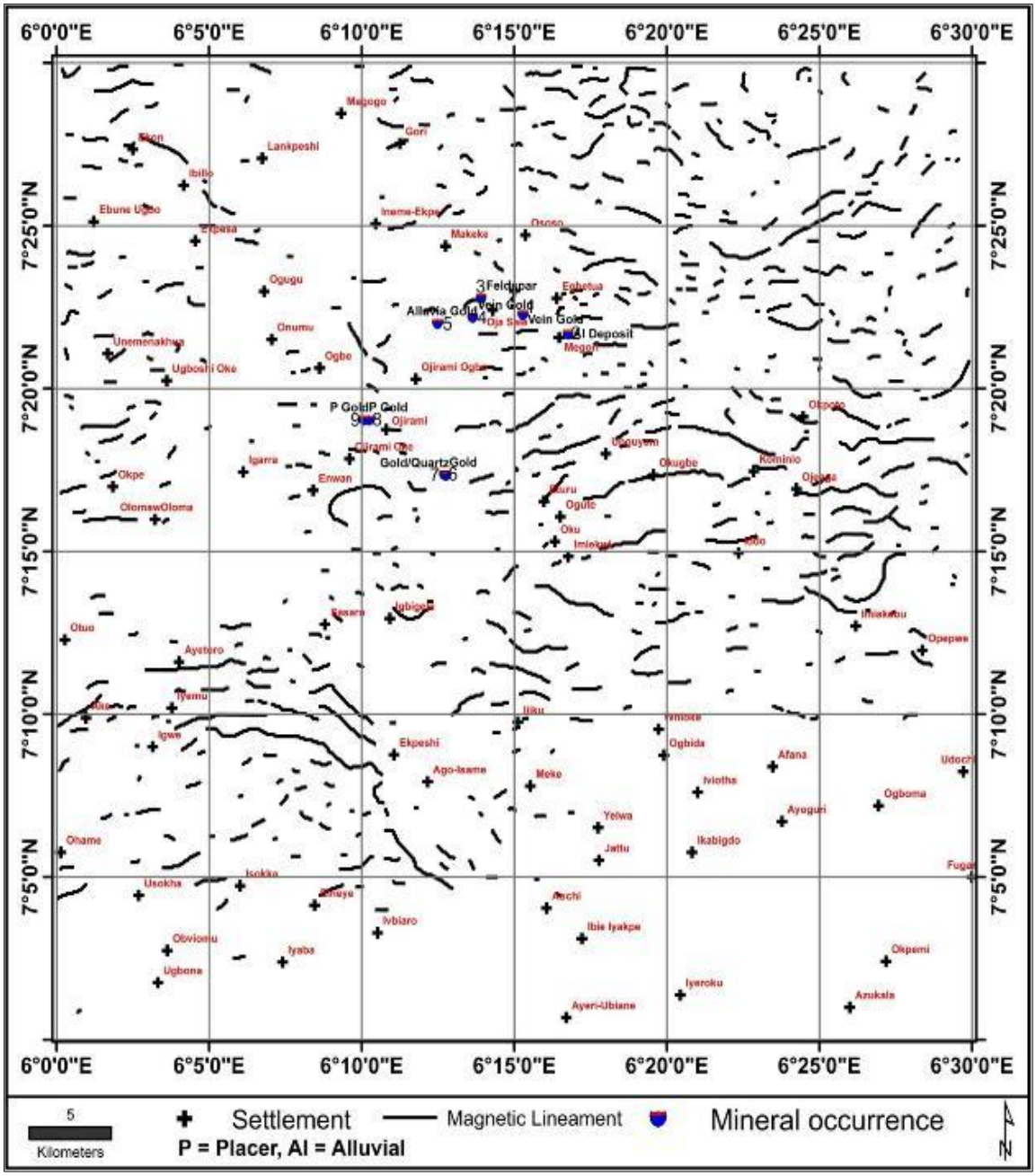

Figure 2 Lineament map showing the Area

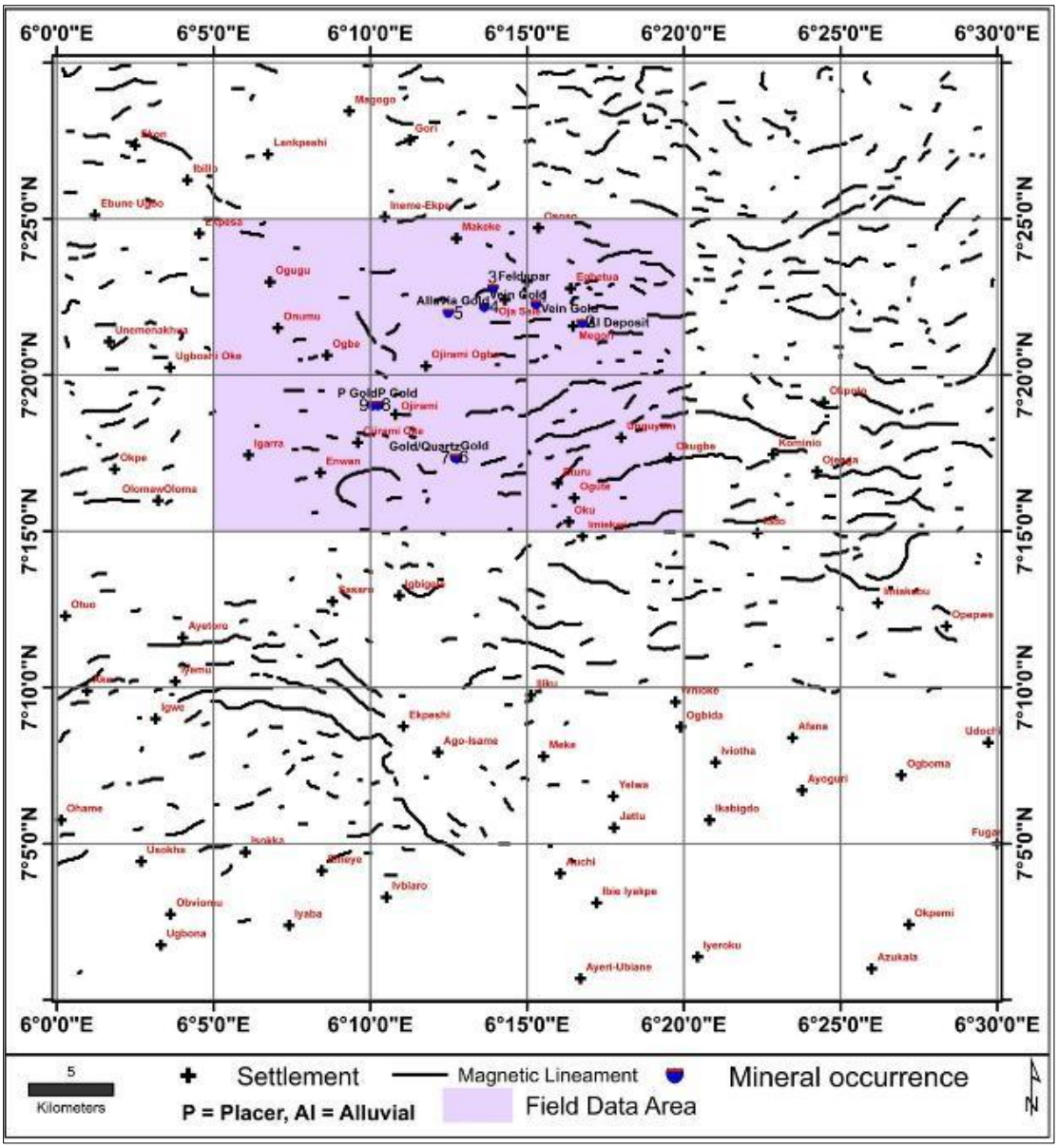

Figure 3 Lineament map indicating Field data Area for enlargement

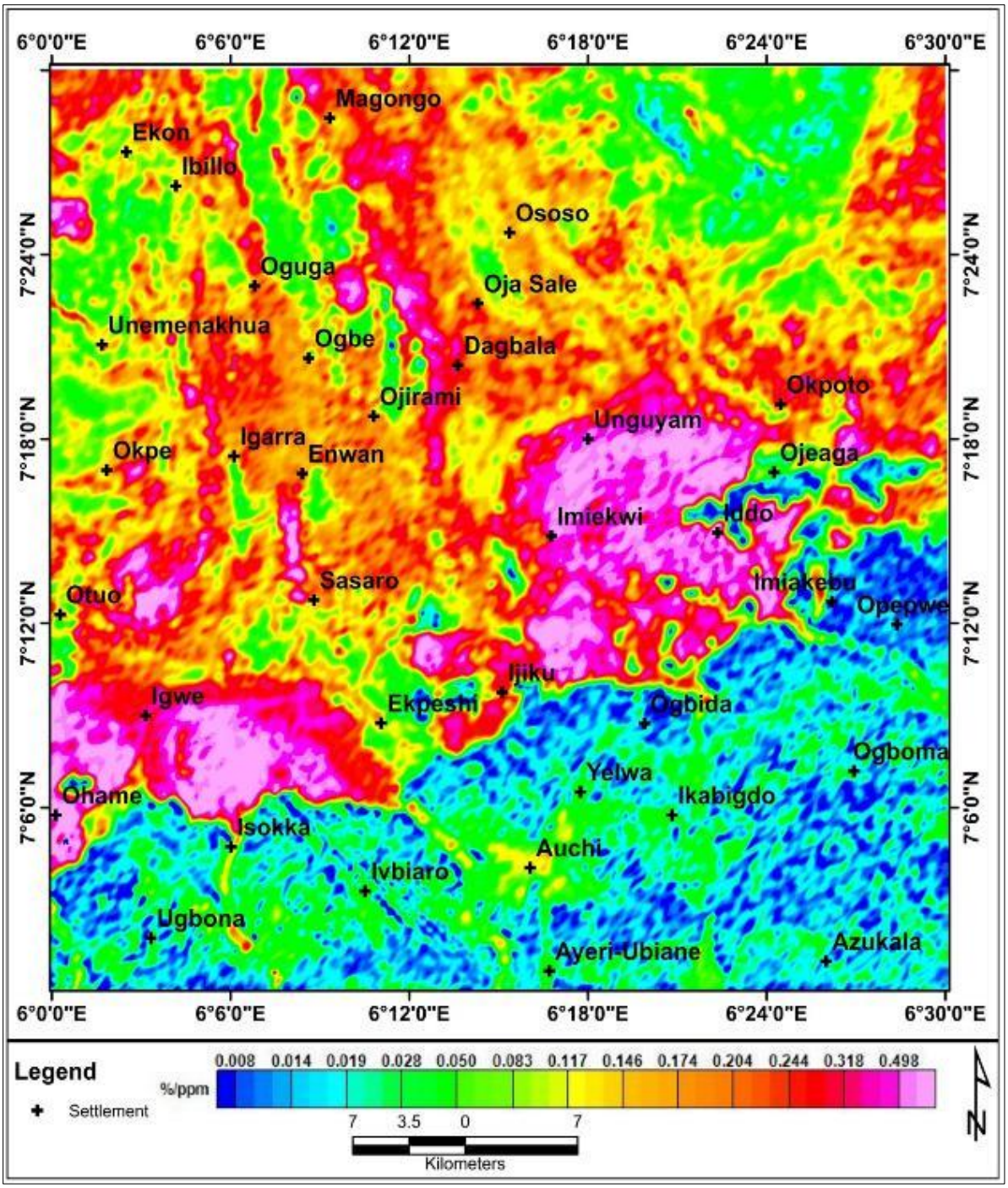

Figure 4 Hydrothermal Alteration Zones across (Auchi Sheet 266)

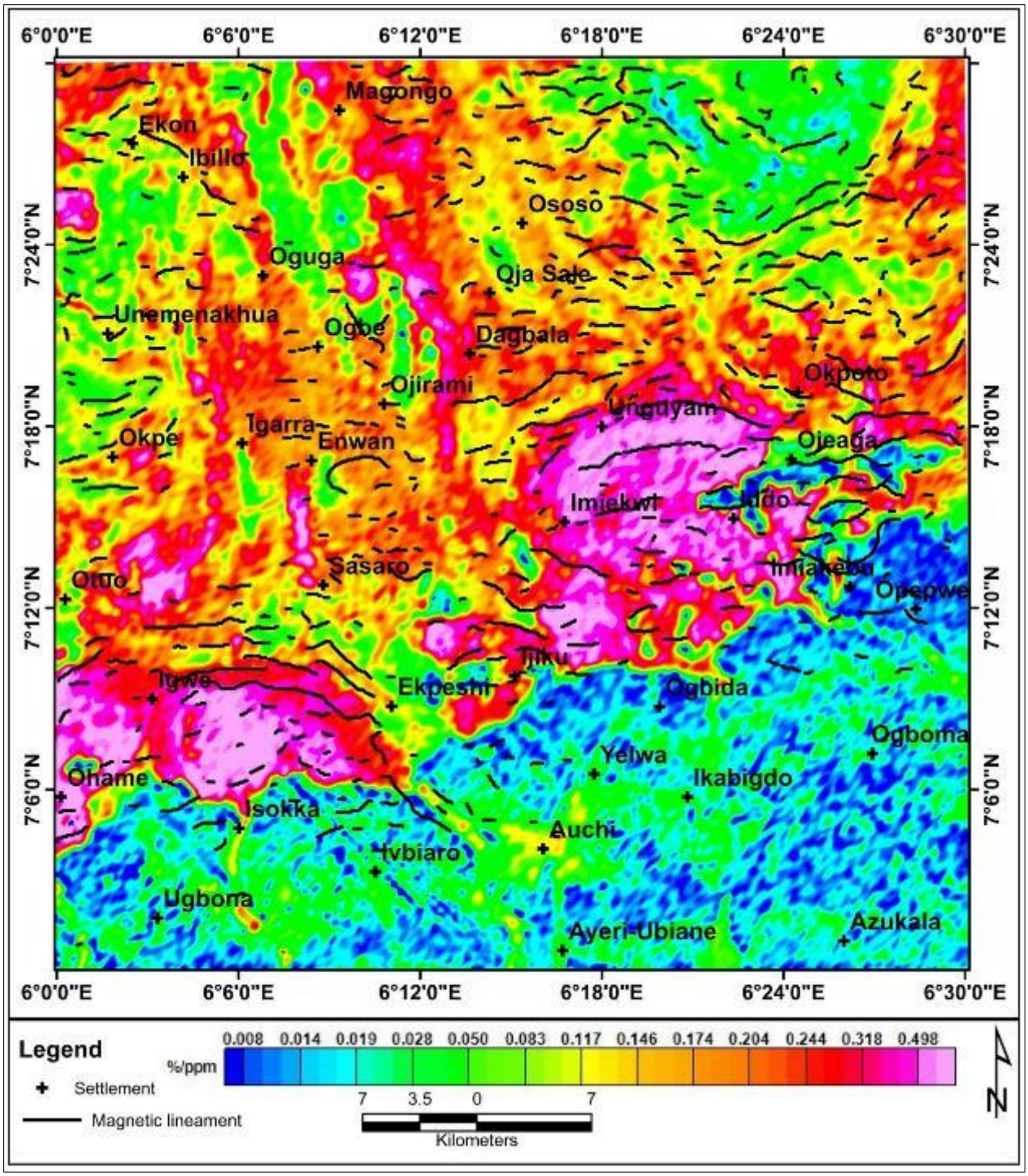

Figure 5 Hydrothermal alterations with structures

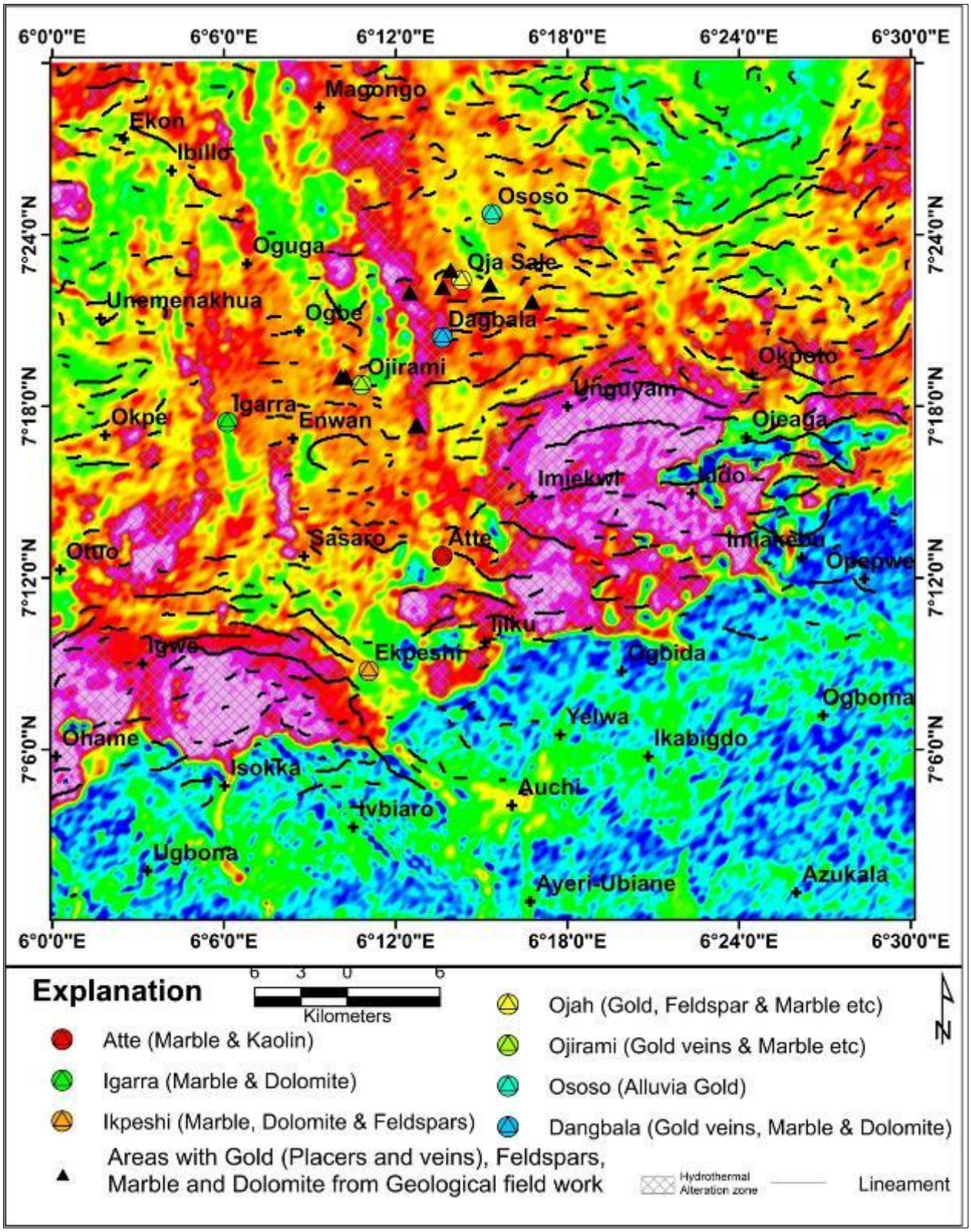

Figure 6 Hydrothermal alteration with structures and minerals from fieldwork

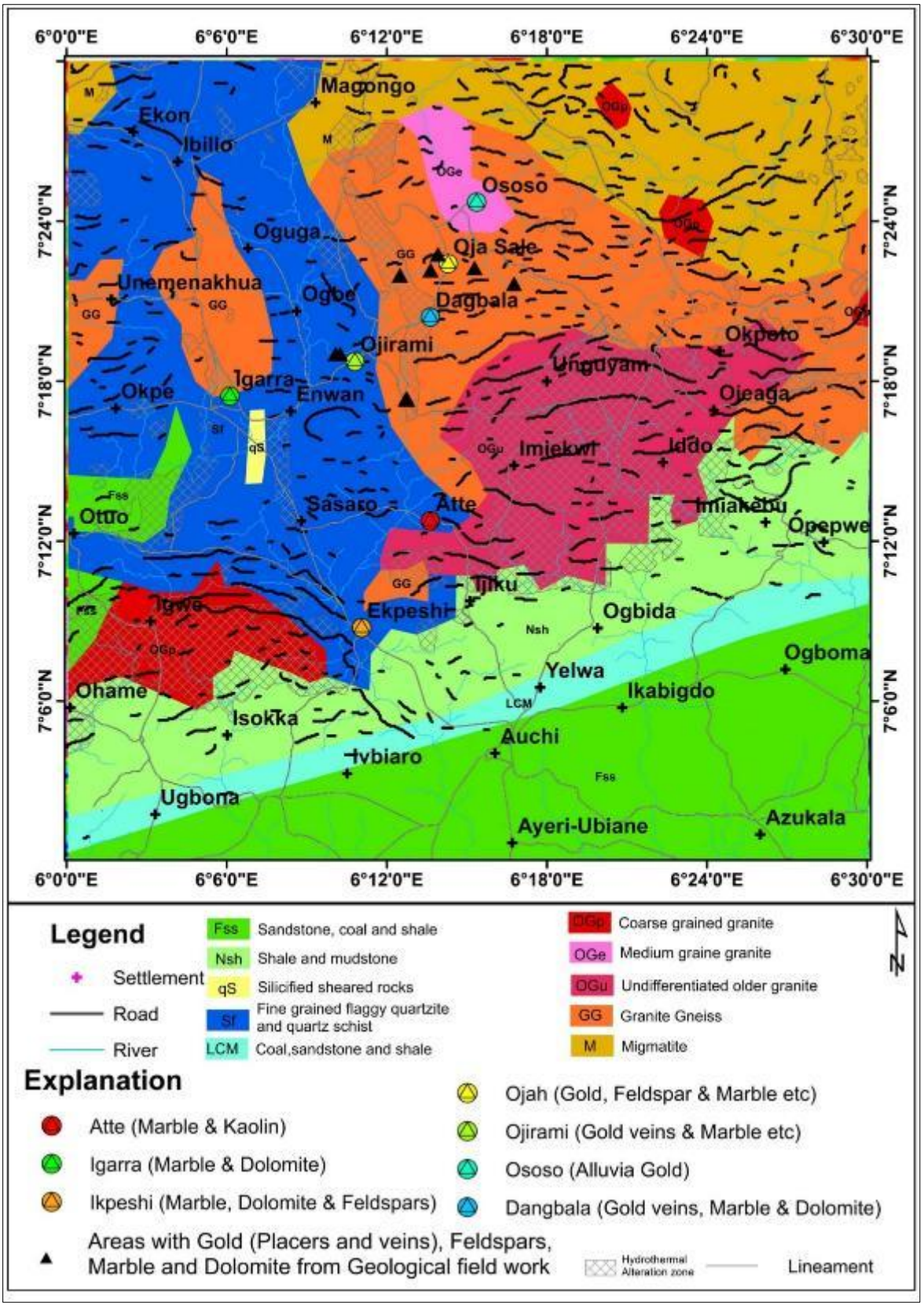

Figure 7 Hydrothermal alteration on geologic map

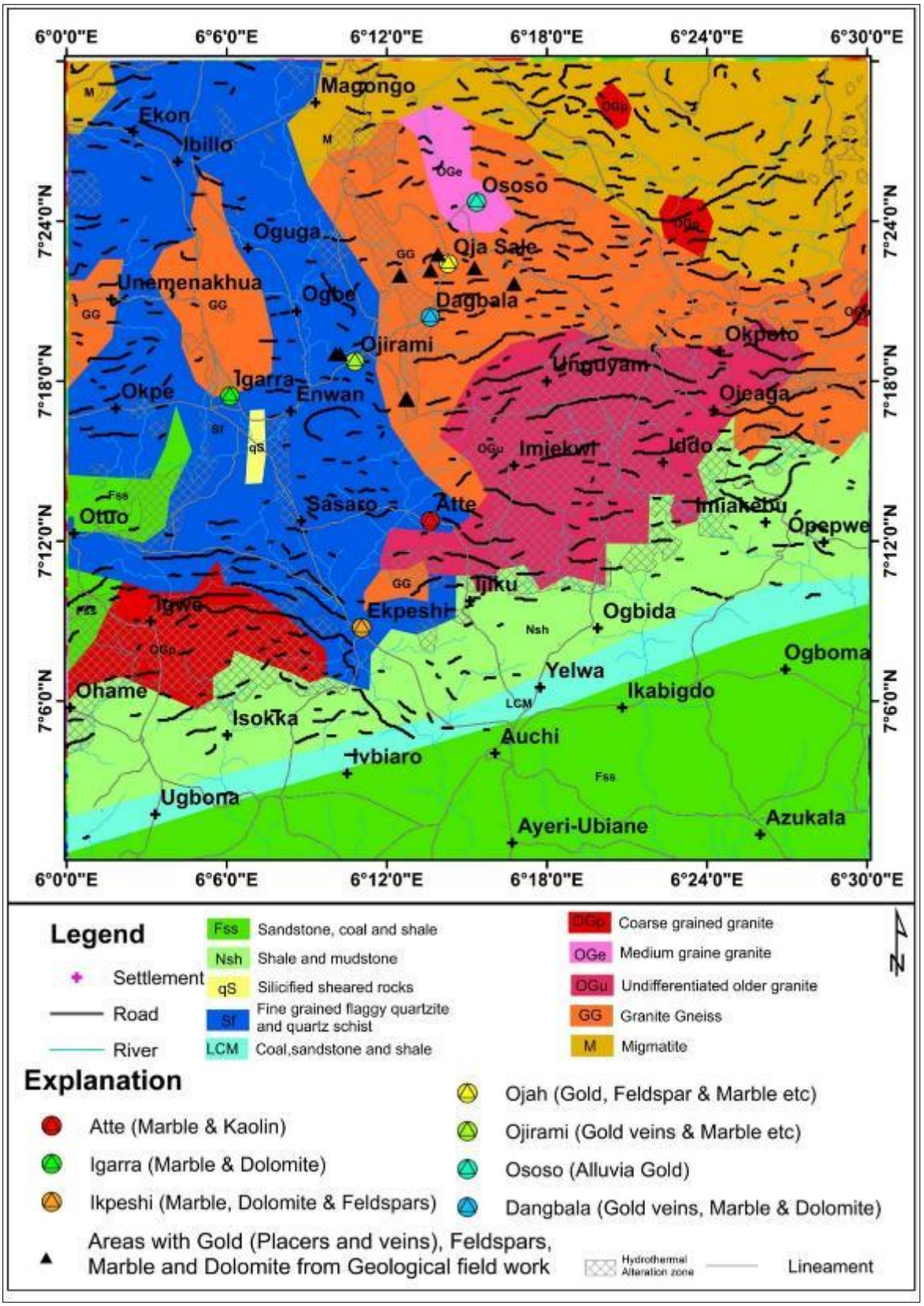

Figure 8 Hydrothermal alteration on geologic map

4. Conclusion

This research contributes to the understanding of gold mineralization potential in Edo North. It provides a detailed mapping of lineaments and hydrothermal zones that are conducive to mineralization. The study also highlights the importance of airborne geophysical surveys in mineral exploration and recommends further studies to assess the economic feasibility of mining in the region.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declared that there is no conflict of interest.

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