

Mineral Potential of Parts of Southwestern Nigeria from Magnetic and Radiometric Methods

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Abstract— The study area is part of Osun State in southwestern Nigeria and falls within the Ilesha schist belt. Airborne magnetic and radiometric data were utilized, provided by the Nigerian Geological Survey Agency (NGSA). The data were gridded and displayed, showing well-defined radiometric highs and magnetic belts. Geophysical mapping and structural analysis were conducted, leading to the identification of potential mineralization zones. The mineral potential map was developed, highlighting areas for further ground investigation. Overall, the study highlighted the presence of mineralized zones in the project area, with geophysical signatures such as high amplitudes of total gradient magnitude anomalies and anomalously high potassium-to-thorium ratios. Follow-up ground investigations using various methods are recommended to establish the mineralization in the study area.

Keywords— Mineralization, Geophysical Mapping, Radiometric Data, Magnetic Anomalies, Mineral Potential, Ground Investigation

I. INTRODUCTION

The occurrences of minerals in Nigeria are mostly associated with tectonic structures and rocks, encompassing faults, folds, intrusions, and the like. The occurrence of metallic ores and deposits of economically significant minerals is intricately linked to specific geological settings. For instance, petroleum is prevalent in sedimentary basins, while tin is commonly found in calc-alkaline ring complexes [1], [2], [3], [4], [5], [6], [7].

Efforts to identify potential mineralized zones often necessitate the delineation of suitable stratigraphic horizons and the recognition of appropriate geological structures like faults, folds, and intrusions. Recognition of anomalous responses arising from different geologic sources is essential for determining the source and for estimating the source location [8], [9], [10], [11]. In most cases, the integration of multiple geophysical methods including magnetic, radiometric and sometimes electrical methods may be suitable for this purpose. The magnetic method is recommended because of its applicability in delineating the lateral and vertical continuity of structures that commonly host minerals, while the radiometric method is suitable for detecting chemical changes resulting from mineral deposition. The study area is part of Osun State in southwestern Nigeria and falls within the Ilesha schist belt – a region that is renowned for gold and associated minerals [12].

II. AIRBORNE MAGNETIC AND RADIOMETRIC DATA

Airborne magnetic and radiometric data used were provided by the Nigerian Geological Survey Agency (NGSA). The data is part of the recently acquired regional high-resolution airborne data of southwestern Nigeria [13], [14], [15]. The flight line and tie-line spacing used to acquire the data were 150 m and 1500 m respectively at an average barometric flight height of about 50 m. Necessary corrections including the removal of background radiation from radiometric data and international geomagnetic reference field (IGRF) from magnetic data were implemented. The resulting data were gridded at 100 m spacing using the Minimum Curvature gridding algorithm and displayed as 2-D magnetic (Fig. 1a) and Radiometric data comprising Potassium (K-map), equivalent Thorium (eTh-map) and equivalent Uranium (eU-map) respectively (Figs 1b, 1c, and 1d). Visual inspection of each of the maps shows many well-defined radiometric highs in specific locations throughout the study area. They equally highlighted a gamma-ray depleted zone. (Fig. 1a) highlighted many magnetic and non-magnetic belts throughout the study area.

