Document Title Geo-Technical Report on Oba Akoko Quarry Site.

Prepared by Egbula .O. J Ph.D s (in View) KWASU, Director and Principal Consultant Geologist

OLUSUSI J.I Ph.D(in View) FUTA, Senior Consultant Geologist

Registered Address No 4, Akinbi close off Shege Bus- Stop,Ijaye-Ojokoro,Lagos

Company No.1411980

Company Name **God Resources Investment Ltd.**

Effective Date 18/08/2025

Competent Person Egbula J.O Ph.D (in View) KWASU, Director and Principal Consultant Geologist

Client Name Williams Taiwo

Client Address No 4, Akinbi Close, off Shege Bus-Stop .Ijaye-ojokoro, Lagos

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1

1.1 INTRODUCTION:

Jinhope Geo-exploration Service Limited was contracted by Williams Taiwo to carry out Visibility study and assessment of an Outcrop and consider the suitability or otherwise for quarry business at Oba Akoko , Ondo State South western Nigeria. Quarry is to produce an aggregates mainly for construction purposes. Ondo state is home to numerous quarry businesses,with several companies operating in the region.The assessment and evaluation program were divided into several phases.

1.2 Aim of the project is to assess an outcrop for the viability of setting a quarry business.

Objective of the project are;

i. Carry Visibility study for the propose Quarry site.
ii. Carry out Litho-lineament mapping of the project site using acquire aeromagnetic Data

1.3 Location and Accessibility

The area covers part of the Owo sheet (265 NW), Southwestern, Nigeria and is located at about 1km off Owo-Ikare Road, of Oba-Akoko town, Akoko North West Local Government Area of Ondo state (Fig.1)

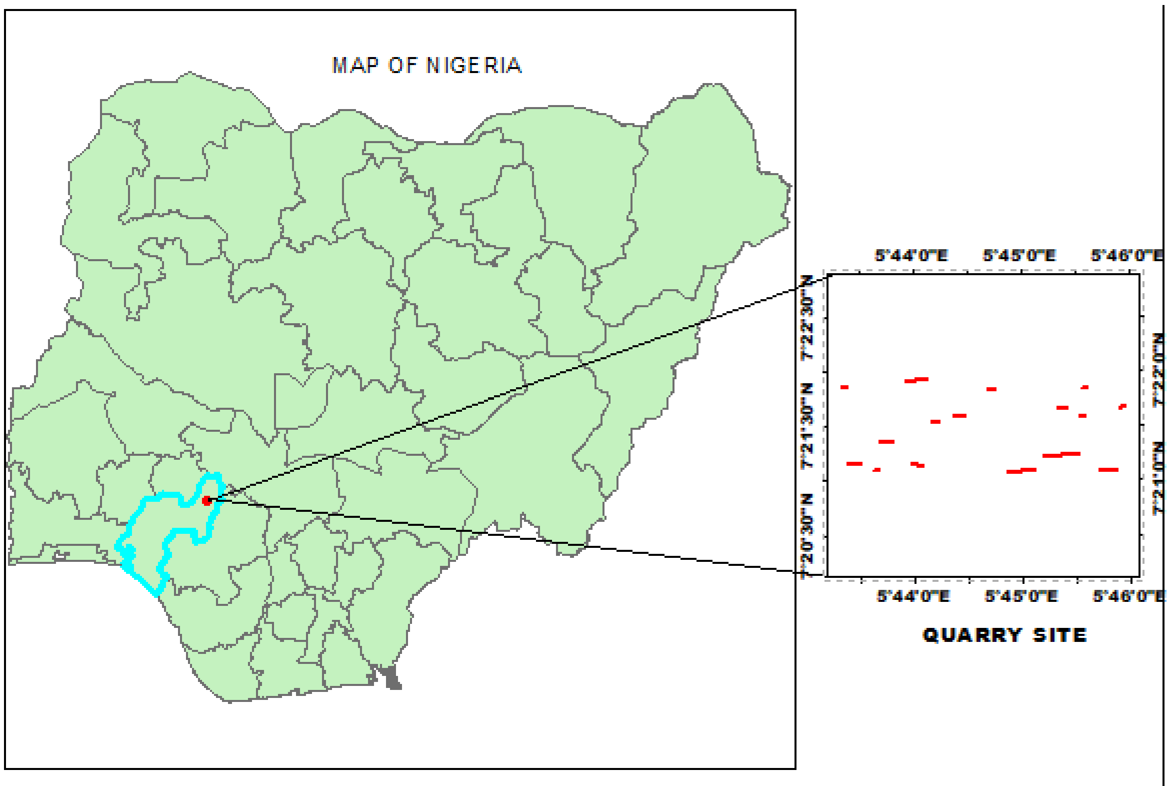

Figure 1: Map of Nigeria Inset , Ondo State and Quarry site.

The Geographical coordinates that describe the Exploration License area is presented in Tables 1.

The area can be accessed from through Ekusi Junction at Oba-Akoko along Owo-Ikare express way. Accessibility within the area is moderately accessible through untarred roads and foot paths within the area. The area is dominated by moderate vegetation which aid moderate foot traversing within the area.

Table 1: Geographical Coordinates of the Area.

	Longitude (DMS)	Latitude (DMS)

A	5° 43' 00"	7° 20' 00
B	5° 45' 00"	7° 22' 00
C	3° 45' 00"	7° 22' 00
D	5° 43' 00"	7° 20' 00

1.4 People and Culture

The area is inhabited by Yoruba people who also exhibit a linguistic repertoire of a local Akoko dialect. They are very religious with Christianity being the commonest. They are predominantly farmers

1.5 Relief and Drainage

The entire area is relatively gently undulating. The peak of the area is 330 meters above the sea level. The area is drained by stream channels flowing in north east direction.

1.6 Climate and Vegetation and Land Use of the Area

The study area falls within the Guinea Savannah of Nigeria with thick vegetation of tropical climatic condition. The area is characterized by two climatic seasons comprising five months of wet season (May-September) with an annual rainfall of about 1000-1500mm and seven months of dry season (October -April). From November-early March, the northeast trade wind known as Harmattan keeps the humidity of the area extremely dry.

Farming is the commonest land use in the study area. This is supported by the presence of well fertile loamy soil of the area. Farming is practiced by traditional methods, which involve the use of hand tools such as hoes, cutlasses, shovel and diggers.

CHAPTER 2

2 GEOLOGY

2.1 Regional Geological Settings of the Area

The study area falls within the Basement Complex of Nigeria that is mainly composed of PreCambrian metamorphic and igneous rocks.

The Basement Complex of Nigeria is part of the Pan-African mobile belt that lies between West African Craton to the West and Congo Craton to the South-east within the African continent (Fig.2). The entire belt lies in the reactivated region which resulted from plate collision between the passive continental margin of the West African Craton and the active Pharusian continental margin. (Burke and Dewey1977) Rahaman (1976, 1988) recognized the following main lithological units of the Basement Complex.

- Migmatite-gneiss-quartzite complex
- Schist-Belts- Metasediments and metalvolcanics
- Charnockitic, Gabbroic and Dioritic rocks
- Older Granites
- Undeformed acid and basic dykes.

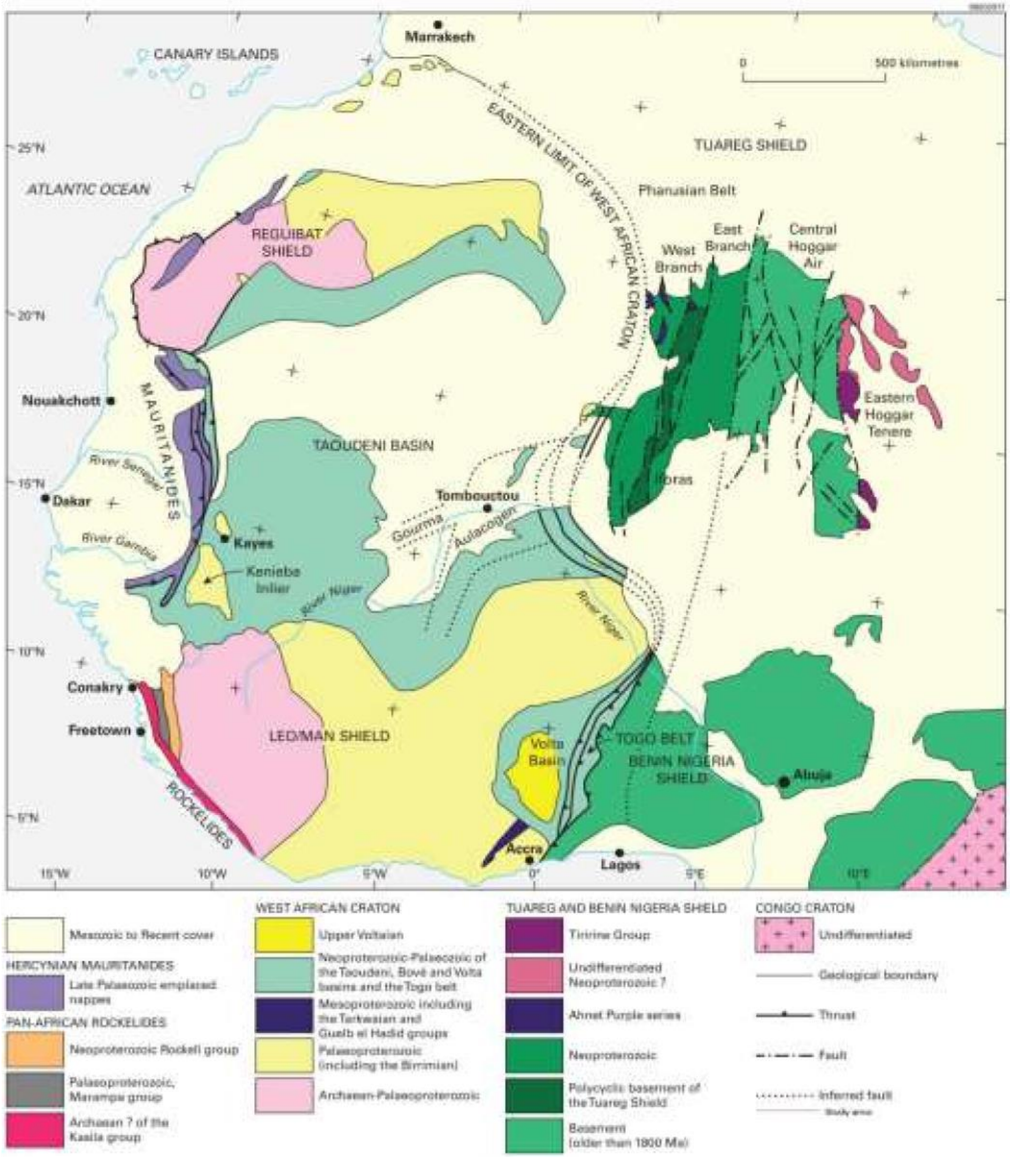

Fig. 2: Regional Geological setting of West Africa. Black (1980)

2.1.1 The Migmatite-Gneiss Quartzite Complex

The Migmatite-Gneiss Complex are the most widespread in the basement. They comprise about 33% of the total surface area of Nigeria and constitute more than 70% of the Basement Complex. Rahaman (1976, 1988) recognized the following petrological units. The Early (Grey) gneiss comprising of a grey foliated gneiss of tonalitic to dioritic composition; The Mafic to Ultramafic rocks and the Felsic components consisting of pegmatites, aplites, quartz-oligoclose veins, fine grained granite, granite-gneiss and porphyritic granite.

The various ways by which the three components interrelate give rise to different types of migmatite structures found in the Nigerian Basement Complex. Isotopic ages ranging from Liberian (2,800 ma) through Eburnean (2,000 ma) and Kibaran (1,100 ma) to Pan-African (600 ma) have been obtained from these rocks [Pidgeon et al. (1976), Grant (1970), Ajibade (1988),

Rahaman et al. (1988),].

2.1.2 The Schist Belts

The Schist Belt consist approximately N-S trending narrow zone of low to medium grained metamorphic rocks of mainly sedimentary and minor igneous origin, which were deposited previously on the pre-existing gneiss-migmatite quartzite basement (Ajibade,1976). Most of the Schist Belts occur in the Western half of the country.

Several different belts have been identified in Nigeria. Some of these include Birinn-Gwari, Kushaka and Maru Schist Belts in the North; Ilesha, Igara and Iseyin-Oyan Schist Belts in the

South. Each belt is separated from others by the rocks of the Migmatite-gneiss complex or the Older Granite.

The Schist Belts are predominantly low grade metasediments composed of pelitic and semi politic schists with subordinate number of conglomerates, marble, banded iron formation, amphibolite, greywakes and volcanic rocks. Ages ranging from the Archean to late Proterozoic have been proposed for the Schist Belts: Kibaran (1,100 ma) by Grant (1970), Ajibade (1988).

2.1.3 Charnockitic, Gabbroic and Dioritic Rocks

Gabbroic and dioritic rocks are more widely distributed of this group and they appear as small bodies and stocks (Rahaman 2003). On the basis of structures and petrography, the charnockitic rocks have been grouped into three viz, the banded or gneissic charnockite, the coarse grained often homogenous sometimes porphyritic foliated charnockites and bauchite, fine-grained basic charnockites (Rahaman 1988). A Pan-African age has been given for the time of emplacement of the charnockitic rocks (Rahaman 1988)

2.1.4 The Older Granites

The Older Granites constitute about 40 to 50% of the Basement Complex outcrops. The group includes porphyritic and non-porphyritic granite, tonalite, granodiorites, quartz-diorites, adamelites and syenite. There are massive as well as weakly to strongly foliated varieties. Rocks of the Older Granites intrude both the migmatite-gneiss Complex and Schist Belts in all part of the basement. Foliation in the rock conformed to the general structural trends in the older country rocks. Available geochronological data from whole rock Rb/Sr and U/Pb studies show that dates for the Older Granites vary from 677 to 518 Ma, which are within the range of age normally ascribed to the Pan-African Orogeny (Rahaman, 1988).

2.1.5 Undeformed Acid and Basic Dykes

The undeformed acid and basic dykes are late to post tectonic Pan-African. They cross-cut the other older rock units described above. They include: (a) The felsic dykes that associate with PanAfrican granitoids, these are pegmatites micro-granite, aplites and syenite dykes and (b) The basic dykes such as dolerite.

CHAPTER 3

3.0 Methodology

3.1 Mapping/ Traverses Covered

The area is systematically transverse to identify the rock units. This adopted with the aid of compass-clinometer, Global Position System (GPS), geological hammer and hand lens. Coordinates of the rock outcrops were taken using a hand-held GPS with which projection were made to the field and taking digital photograph of the rock outcrops.

3.2 AIRBORNE MAGNETIC DATA

Geophysical interpretation of the aeromagnetic data of sheet 265 (Owo), southern Nigeria was carried out with the purpose of understanding the regional lineament trend.

3.3 DATA PROCESSING AND INTERPRETATION

High resolution Airborne magnetic data Map(1:100,000)of sheet 265 in excel format acquired from Nigerian Geological Survey Agency . The acquisition parameters of the aeromagnetic data are- Flight line spacing (500m), tie line separation (1.5km), Terrain clearance (50m), Flight direction is NW-SE, while the Tie line direction NE-SW. The aeromagnetic data were later produced as a total magnetic intensity (TMI) map in a grid cell size of the 5000 m interval using Geosoft (Oasis Montaj™) version 8.4.0 (HJ) software. Enhancement of the TMI involved removal of unwanted high-amplitude short-wavelength features using non-linear filtering (Kazeem et al.,2022).Enhanced TMI reveals faults and fracture corridors that control fluid flow and rock mass behavior (Telford et al.2024). .

RESULT AND DISCUSSION

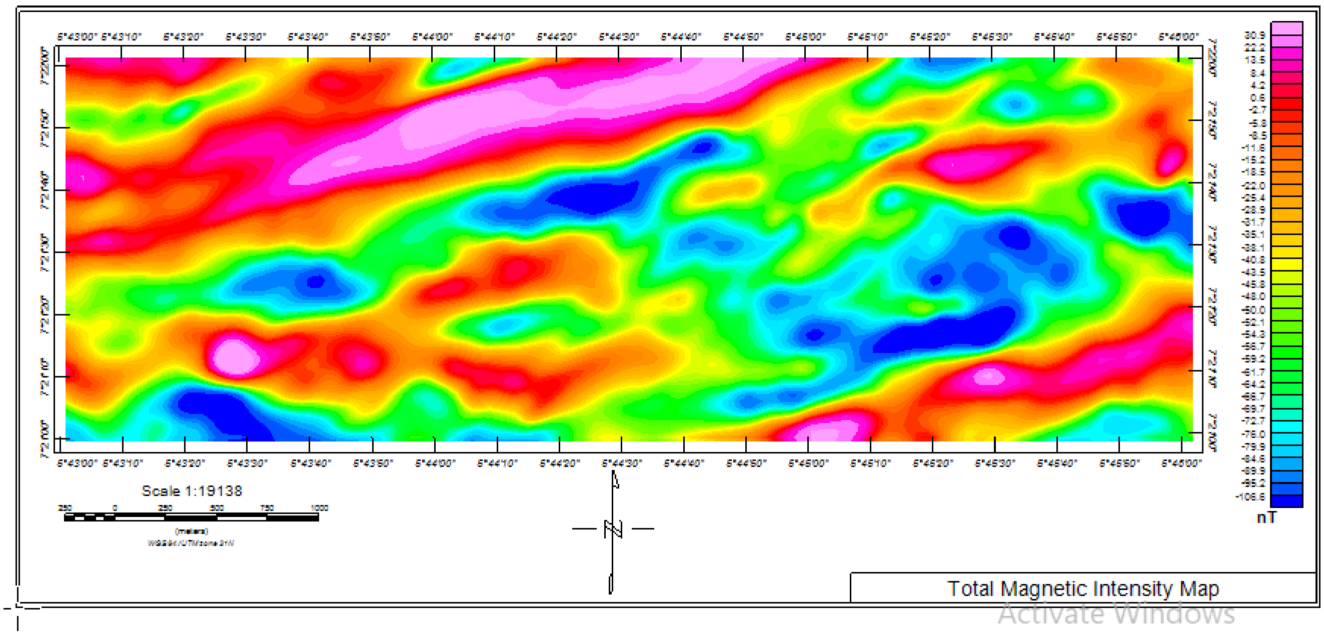

Figure 3: Total Magnetic Intensity Map of The Quarry site.

4.1 Total Magnetic Intensity (TMI)

Figure 3 shows the total magnetic intensity map (TMI) of the study area; it provides useful and important information for the delineation of important structural architecture of the subsurface. It emphasises that the intensity and the wavelengths of local anomalies shows a magnetic intensity range of −106.8nT to 22.2nT, suggesting contrasting rock types in the quarry site.

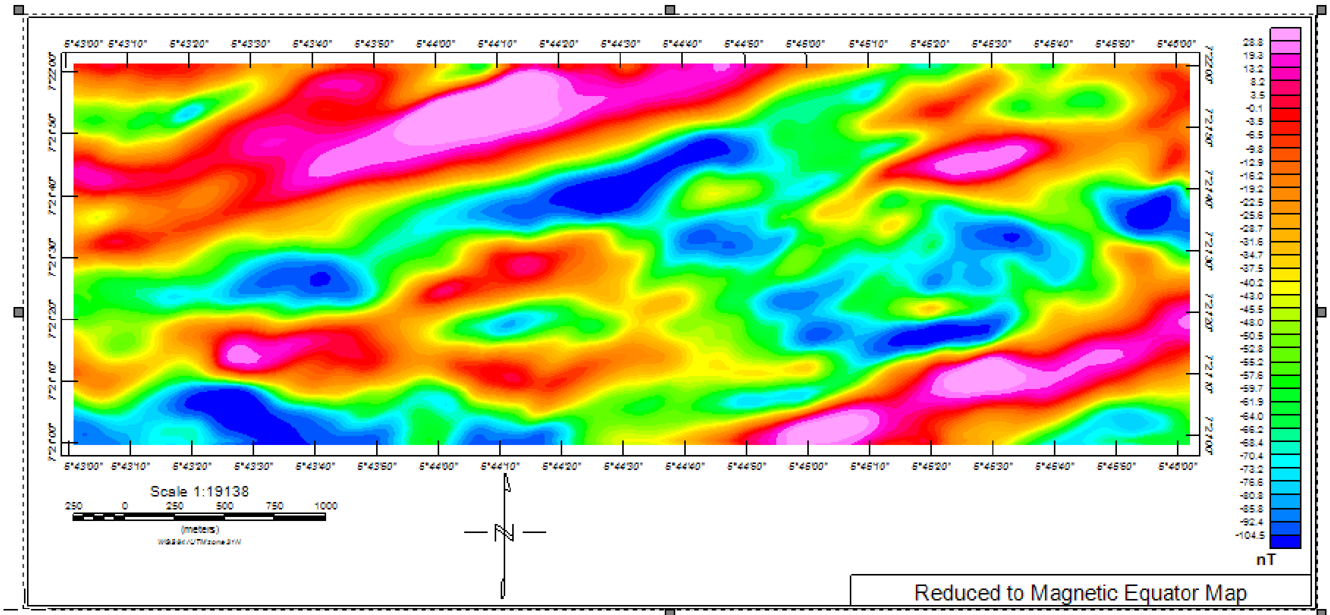

Figure 4: Reduce to Magnetic Equator Map of The Quarry site.

4.2 Reduction to Magnetic Equator(RTE)

The output of the Total Magnetic Intensity map of the study area, which was reduced to the equator, is presented in Figure 4. Figure 4 is similar to the Total Magnetic Intensity (TMI) anomaly map of the quarry site because of the low magnetic angle of inclination (< 15°) in the project area .In a low magnetic latitude regions around the equator where the quarry site is situated, positive magnetic intensity values in pink colours and negative magnetic intensity values in blue colours of amplitude magnetic anomalies due to magnetic effects of different lithologies and geologic materials correspond to low and high magnetic

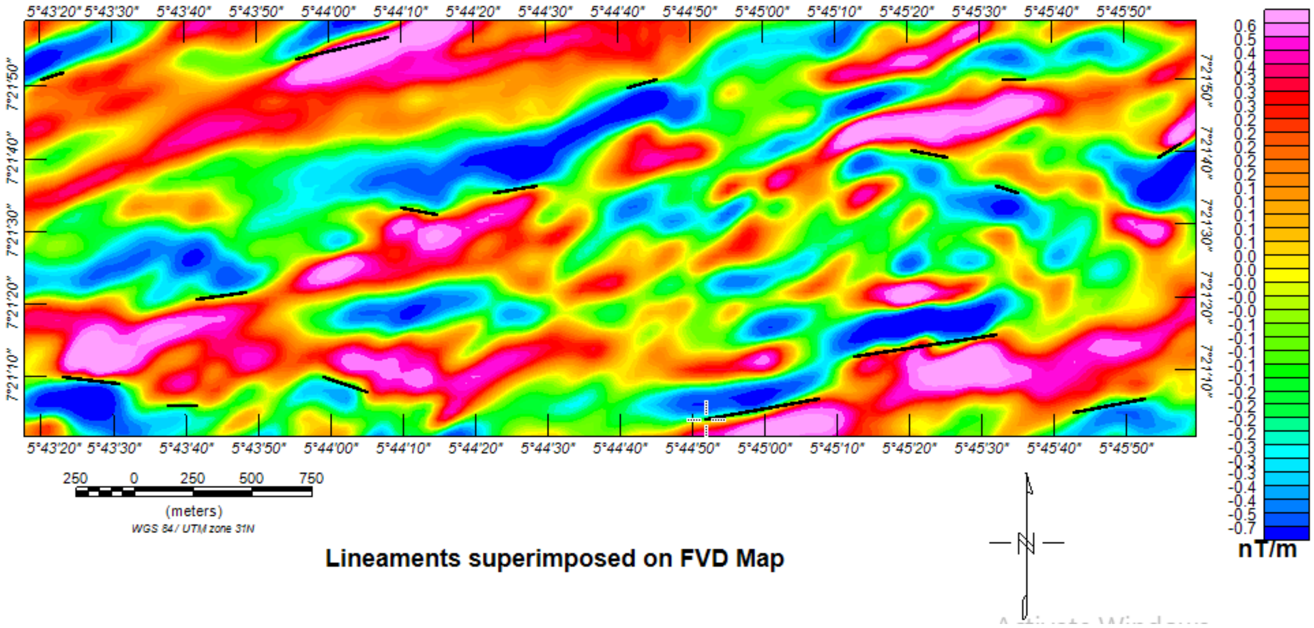

Figure 5: Lineaments Superimposed on FVD Map of The Quarry site.

4.3 First Vertical Derivative (FVD)

Figure 5 shows a first vertical derivative map of the study area. From comparison of Figure 5 with Figure 4, structural features such as faults, fractures and folds, not visible in Figure 4, are well pronounced on Figure 5. It reflects clearly enhancement of structural features that probably serve as a major pathway for hydrothermal activity in the study area. Observation on Figure 5 revealed two types of lineaments. These lineaments can be classified as (1) major lineaments trending in the NE-SW direction and (2) minor lineaments trending in NW-SE and E-W directions. These lineaments are associated with faults, fractures, dykes, joints and veins

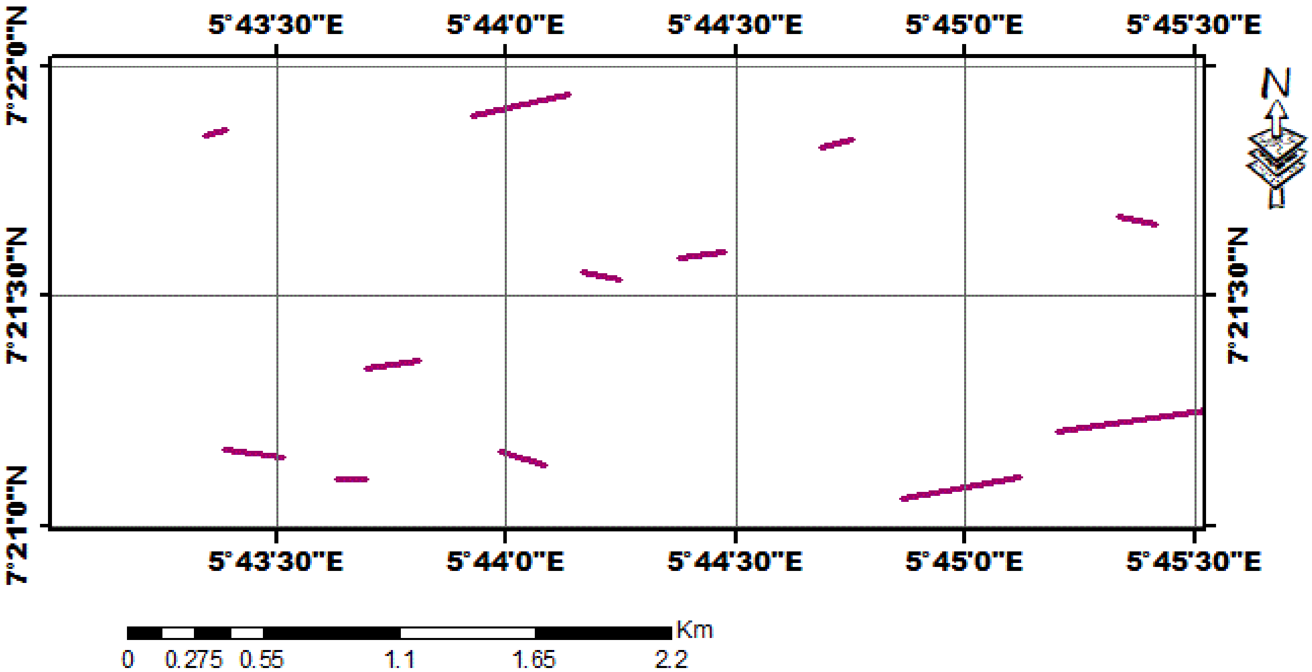

Figure 6 : Aeromagnetic Lineaments Map of The Quarry site.

4.4 Lineaments Map

The lineaments map of the quarry site has shown in fig.6, this has suggests some structural significance and geological implications.

Structural significance

The extracted features are **linear magnetic anomalies**, interpreted as **faults, fracture zones, or lithological contacts** within the basement or cover rocks (Oladunjoye et al. (2016).

Their **consistent short segment lengths** suggest localized structural discontinuities, likely representing brittle fractures or shear zones rather than long, regional faults(Okoro et al. (2021)).

Given the roughly **ENE–WSW to NE–SW** orientations visible here, they may belong to one of the **Pan-African conjugate fracture sets** common in SW Nigeria, which are often associated with mineralization, groundwater flow, and structural controls on quarry rock mass quality(Salako et al. (2020)).

Geological Implications

Brittle reactivation of older structures — These lineaments may represent zones where ancient shear zones were reactivated during later tectonic phases, creating localized deformation.

Lithological boundaries — Some could coincide with changes in magnetic susceptibility caused by differences between granitic, gneissic, or schistose basement rocks.

Weathering and erosion patterns — Over time, lineaments may correspond to topographic lows (valleys, drainage lines) due to preferential weathering.

Economic

Mineral exploration — Such structures can focus hydrothermal fluids, making them potential exploration targets for gold, pegmatite-hosted minerals, or base metals.

Quarry development — Mapping these is crucial to anticipate block sizes, stability issues, and groundwater inflow paths.

Groundwater management — In hard rock terrains, fractures and faults mapped as magnetic lineaments are primary aquifer zones.

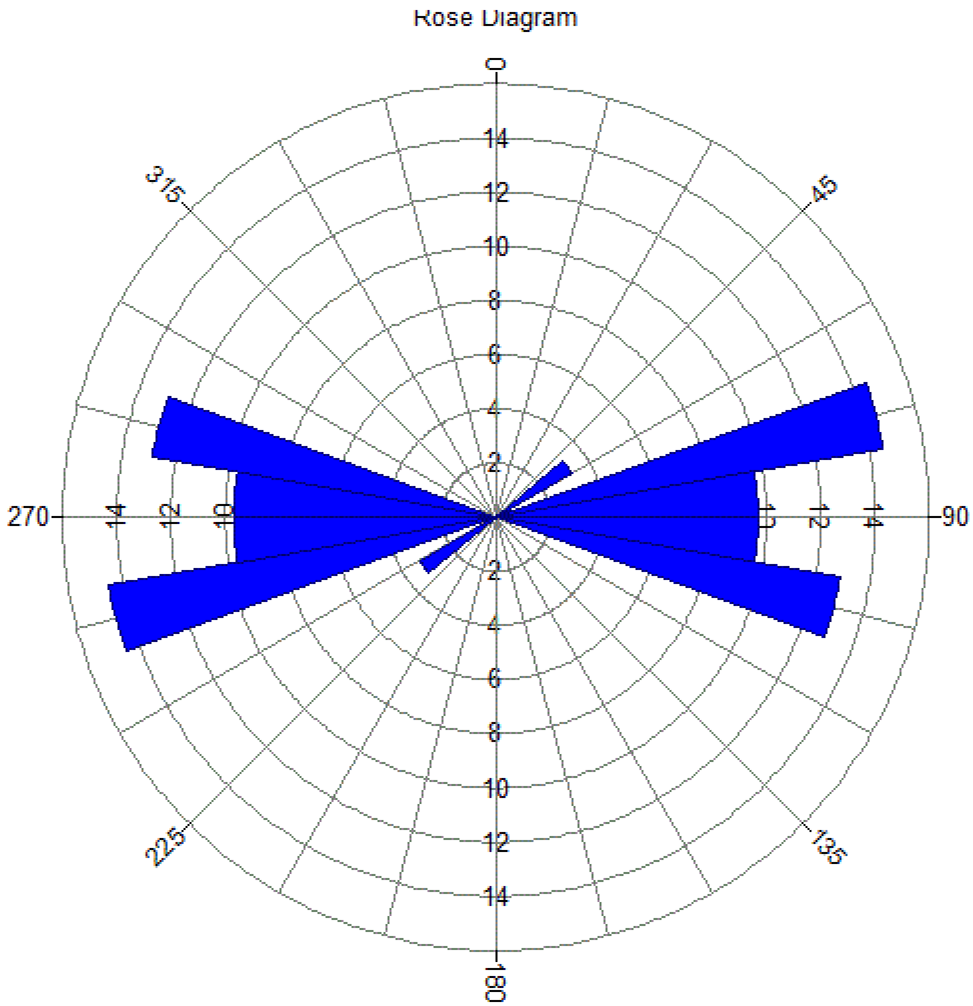

Figure 7: Rose diagram of The Quarry site.

The Rose diagram shows the trending of both the major lineaments and subsidiary lineaments at the quarry site.

Conclusion.

It is crystal clear that the fundamental understanding of the fracture lines and direction will have a great impact towards the productivity, efficiency, safety and sustainability as well as creating a room for efficient cost management in quarry business as someone consider some key relevancies.

Fracture lines and directions in rocks are crucial for quarry operations because they can sig_nificantly impact the efficiency, safety, and cost-effectiveness of extracting rock materials. Here are some key relevancies:

1. Extraction Efficiency
Fracture lines can determine the natural breakage patterns in rocks, allowing quarry operators to extract rock blocks more efficiently. By understanding the orientation and frequency of fractures, operators can optimize cutting and blasting techniques to minimize waste and maximize usable material.

2. Rock Stability
Fracture directions can influence the stability of quarry walls and benches. Understanding these patterns helps in designing safe pit slopes and preventing rockfalls or slope failures, which can be hazardous to personnel and equipment.

3. Blasting and Fragmentation
Knowledge of fracture patterns allows for more effective blasting designs. By aligning blasting patterns with natural fracture directions, operators can achieve better rock fragmentation, reducing the need for secondary breaking and improving the overall efficiency of the operation.

4. Rock Quality and Yield
Fracture density and orientation can affect the quality and size of the rock blocks that can be extracted. In quarries producing dimension stone, understanding fracture patterns is essential for maximizing the yield of high-quality blocks.

5. Safety
Fracture analysis helps in identifying potential hazards such as unstable rock blocks or areas prone to rockfalls. This information is critical for implementing safety measures and reducing the risk of accidents.

6. Cost Reduction
By optimizing extraction methods based on fracture patterns, quarries can reduce operational costs. Efficient extraction and blasting techniques minimize waste, reduce equipment wear and tear, and lower energy consumption.

7. Planning and Design
Fracture data is essential for long-term planning and design of quarry operations. It helps in determining the most economical and safe way to extract resources over the life of the quarry.

In summary, understanding fracture lines and directions is fundamental to optimizing quarry operations, ensuring safety, and maximizing the economic viability of the operation.

Recommendation

Based on the integrated results of the visibility analysis and litho-structural (lineament) mapping, the proposed site is adjudged suitable for sustainable quarry operations.

The **visibility study** indicates that the site's visual exposure is minimal from major settlements and transportation corridors, thereby reducing potential visual impact and enhancing community acceptance. The **lineament analysis** reveals that the area exhibits favourable structural conditions — with lineament density and orientation that are unlikely to compromise slope stability, yet sufficient to facilitate controlled fragmentation during blasting.

In addition, the lithological assessment confirms the presence of competent, high-quality rock units suitable for the intended quarry products. The combination of low visual impact, structurally favourable conditions, and desirable lithology positions the site as optimal for quarry development.

It is therefore recommended that:

1. **The identified zone** of fracture be prioritized for quarry development.
2. A **detailed geotechnical investigation** (including rock mass rating, discontinuity mapping, and slope stability analysis) be undertaken prior to full-scale extraction.
3. **Environmental baseline studies** be conducted to establish current environmental conditions and guide mitigation planning.
4. **Progressive rehabilitation measures** be incorporated into the quarry design to maintain environmental sustainability.

However, all the aboved recommendation could be best monitored and properly supervised by our company (Jinhope Geo-exploration Service Limited **)** after proper and necessary negotiation had been completed with our director.

. **REFERENCES**

Ajibade,A.C.and Fitches,W.R(1988). The Nigerian Precambrian and the Pan African Orogeny In Precambrian Geology of Nigeria.Geological Suvey of Nigeria pp.45-53

Ajibade, A.C. (1976). Provisional Classification and Correlation of the Schist Belts of Northwestern Nigeria. In: C.A Kogbe (ed) Geology of Nigeria pp85-90, Elizabeth Publishing Co.

Black, R. (1980). The Precambrian of West Africa. Episodes, 1980, no. 4(Dec): pp3-8.

Burke, K.C and Dewey, J.F. (1972). Orogeny in African. In Dessauragie, T.F.J and Whiteman, A.J (eds) African Geology, University Ibadan 1970. pp583-608.

Grant, N.K. (1978). Structural distinction between a metasedimentary cover and an underlying basement in the 600m.y. old Pan African domain of Northwestern Nigeria, West Africa. Geological Society of American Bulletin, 89, 50-58

Kazeem O. O., Sunday B., Olufemi A. A., Gbenga M. O., Oluwatoyin K. O.(2022). Aeromagnetic Mapping and Radioelement Influence on Mineralogical Composition of Mesothermal Gold Deposit in Part of Ilesha Schist Belt, Southwestern Nigeria. Nriag Journal of Astronomy and Geophysics vol.11,No1,177-192

Oladunjoye, M.A., Olayinka, A.I., Alaba, M., & Adabanija, M.A. (2016). Interpretation of high-resolution aeromagnetic data for fracture mapping in Ogbomoso area, SW Nigeria. *Journal of African Earth Sciences,* 124, 1–13.

Okoro, E.M., Onuoha, K.M., & Oha, I.A. (2021). Aeromagnetic interpretation of basement structure and architecture of the Dahomey Basin, SW Nigeria. *Journal of African Earth Sciences*, 180, 104–134.

Rahaman, M.A (1976) Review of the basement Geology of Southwestern Nigeria. In

Kogbe, C.A. (ed.) Geology of Nigeria, Lagos, Elizabethan Pub. Co, Lagos, pp 41-58

Rahaman, M.A. (1988). Recent Advances in study of the Basement Complex of Nigeria Precambrian geology of Nigeria. In: Oluyide, P.O. et al., (eds) Precambrian Geology of Nigeria. Geological Survey of Nigeria Publication, Kaduna, 11-43.

Salako, K.A., et al. (2020). Delineation of structural features from aeromagnetic data of parts of SW Nigeria: Implications for mineral exploration. *Geocarto International*, 35(4), 371–389