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Evaluation Of Amaubiri Diorite Deposit For Quarry Purposes

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Abstract: ***Amaubiri, southeastern, Nigeria was investigated for the purpose of establishing the presence of rock material suitable for quarrying activity. Geological study revealed that the rock matter is a diorite with mean density of 2.84 x 10^3kgm^{-3}. The rock matter of interest displayed calcite ($CaCO_3$) filled veins with visible olivine and pyrite minerals. The photomicrograph of the rock sample further revealed strands and laths of labradiorite, clusters of olivine, augite and calcite set in a ground mass of smaller plagioclase, iron oxide and pyroxene. The geoelectric section obtained from the geophysical investigation using Schlumberger configuration revealed three to four layers with diorite encountered at all the locations along profile P1 and P2 except at location P19. The study revealed diorite of very high quality with appreciable reserve projected at 2.49 million metric tons.***

Keywords: Diorite, reserve estimation, quarrying, photomicrograph and geophysical survey.

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I. INTRODUCTION

Southeast, Nigeria like most part of the world is underlain by rock matter of one type or another. The quality and quantity of an identified rock deposit for an intended use determines the need for its exploration and subsequent exploitation.

Part of Amubiri bounded by latitudes 5^0 54.80'N to 5^0 55.10'N and by longitudes 7^0 26.90'E to 7^0 27.18'E (Fig.1) was investigated to confirm the suitability of underlying rock matter for quarrying purposes.

The study area is uninhabited and used mostly for agriculture as subsistence farming is the major means of livelihood of the people of the area. The elevation of the area ranges from 80.5m to 104.3m. Northeastern part of the surveyed area is highly undulating with a major ridge trending 310^o. The study area is also characterized by Enugu escarpment in the west.

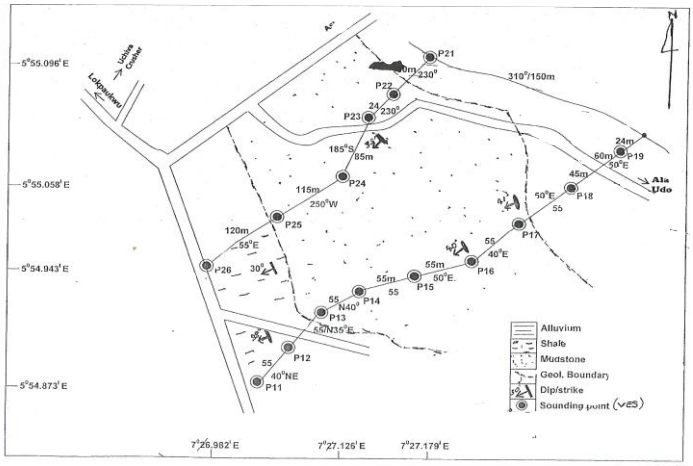

Figure 1: Location and Accessibility Map of the study area

Geologically, the study area is located within the lower Benue Trough of Nigeria. The Benue Trough is defined as an intercontinental late Jurassic to early Cretaceous Basin about

1000 km in length stretching in NE–SW direction and resting unconformably upon the Precambrian basement (King, 1950; Farrington, 1952; Nwachukwu, 1972; Murate, 1970; and Jones, 1964). Based on the Trough corresponding geological and geomorphologic partition, it is subdivided into the upper, middle and lower region (Carter et al. 1963; Reyment, 1965). It comprises of the Abakaliki Anticlinorium, and Afikpo Synclinorium in the east and bounded by Anambra Basin in the west.

Stratigraphically, the lower Benue Trough is controlled by three cycles – marine, transgressive and regressive cycles (Murat, 1972). The first marine transgressive phase in the middle to late Albian resulted in the deposition of the Asu River Group sediments. Asu River Group Lithostraigraphic pile includes sandstone, siltstone, shale and limestone occurrences (Reymont, 1965). Whiteman, (1972) also established that the Albian, Asu River Group is made up of sandstones, limestones, mudstones and intermediate intrusive such as diorite, dolerite and over-flown by basaltic suites during the Santonmian period. This is evident in areas like Lekwesi, Ishiagu, Abakaliki, Lafia Egbede hills, Agilla and Lokpaukwu within the lower Benue Trough.

II. MATERIALS AND METHODS

The study involved an extensive geologic field mapping to identify rock deposits and outcrops, geophysical investigation to determine the downward trend of identified rock matter as well as laboratory analysis for quality assessment. The study also estimated the reserve of the rock deposit in the area for its quarrying potentials.

Fifteen vertical electrical sounding (VES) were carried out in the area using Abem Terrameter SAS 1000 model to determine the thickness and extent of the rock material of interest. The coordinates of VES locations were obtained using Garmin 76CSX Global Positioning System (GPS). Laboratory analysis was carried out to establish the significance of the rock material for quarry. Petrographic analysis for physical and textural feature examination and Archimedes principles for density determination were carried out in the Geology Laboratory of Nnamdi Azikiwe University Awka, Nigeria.

For the vertical Electrical sounding (VES) using Schlumberger configuration, AB/2 values ranged from 1.5 to 55m, ensuring up to 37m of depth of penetration, which determined the over burden and intrusion thickness in the study area. Field readings in ohms were reduced to apparent resistivity values through the Schlumberger equation.

$Pa = \pi (a^2/_b - {}^b/_4) R$

Where;

Pa = apparent resistivity in (ohm – m), a = Half current electrode separation in (m)

B = potential electrode separation in (m), R = Meter Readings in (ohms)

Plots of Pa values against AB/2 values on log-log graphs gave the field curves

III. RESULTS AND INTERPRETATION

Field observations indicate that the prevalent geologic units of mudstones and shales were intruded by diorites. Rock samples collected from the area have veins filled with calcite ($CaCO_3$), indicative of minor faulting. The calcite veins are medium-grained with visible olivine and pyrite minerals. The colour of the diorite is dark grey under the microscope, strands and laths of labradiorite, clusters of Olivine, augite and calcite are set in a ground mass of smaller plagioclase, iron oxide and pyroxene (plate 1& 2). The texture conforms to the intermediate igneous rocks.

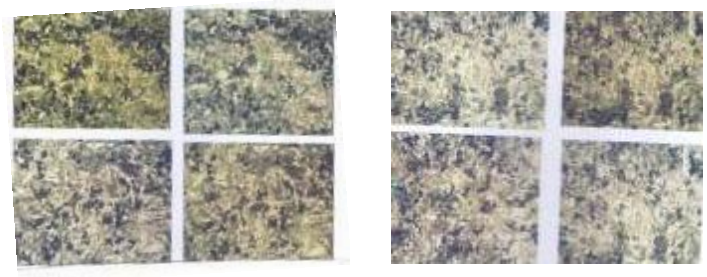

Plate 1 & 2: Photomicrograph of diorite rock x 40 x PL with veins filled with calcite

Rock density studies were performed using eight (8) different samples. The study was done to confirm the quality of the rock. Table (1) shows the result of the study. The samples collected were first weighed in the air and subsequently reweighed in water of density 1.00 x 10^3Kgm^{-3} to determine the dry density. It was then soaked in water for 48hours and the wet density determined. The average of the dry and wet density was taken as the mean density.

Samples	1	2	3	4	5	6	7	8
Dry density (PD)	2.85	2.78	2.89	2.81	2.86	2.91	2.88	2.88
Wet density (Pw)	2.81	2.75	2.86	2.79	2.82	2.90	2.82	2.86
Sample density (P)	2.83	2.77	2.88	2.80	2.84	2.91	2.85	2.87
Mean density = 2.84 x 10^3kgm^{-3}								

Table 1: Result of density analysis of diorite samples (x $10^3 kgm^{-3}$)

The density of the samples (P) ranged from 2.77 x 10^3kgm^{-3} for the calcite-rich variety to 2.91 x 10^3kgm^{-3} for the iron-rich variety with a mean value of 2.84 x 10^3kgm^{-3}. This is inline with the known density of diorites which ranges from 2.60 to 2.95 x 10^3kgm-^{3}.

IV. GEOPHYSICAL INTERPRETATION

Curve shapes and not necessarily the resistivity values are employed in resistivity sounding data interpretation. This is because the values of resistivity may vary due to wetness or dryness depending on climatic condition but the real depths to geoelectric layers remain constant. Thus curve shapes were used to infer the number of geoelectric layers prior to modeling.

The Fifteen (15) VES data obtained were run on a zohdy software to generate true values of resistivity and depths to

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geoelectric layers. Three to five geoelectric layers were interpreted for the fifteen VES points. The overburden thickness ranges from 2.2m at P_{13} to 18.4m at P_{22}. Diorite was not encountered at P_{19}. Fig. 2 shows typical resistivity curves obtained in the area.

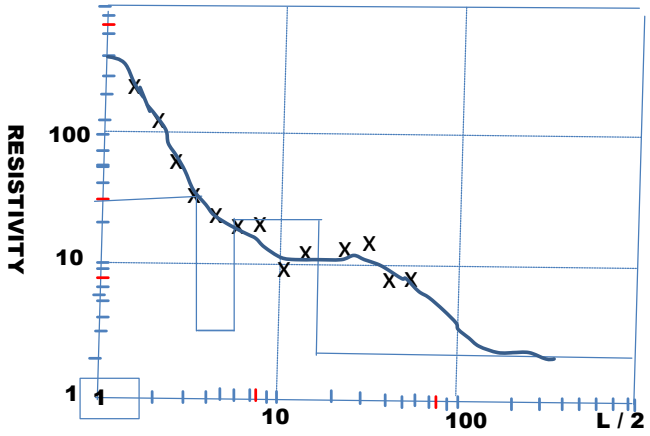

Figure 2: Typical resistivity curve obtained in the area

The geoelectric sections along profile P_{11}-P_{19} and P_{26} - P_{21} showing the downward trend of the diorite are presented in Fig. 3 and 4 respectively

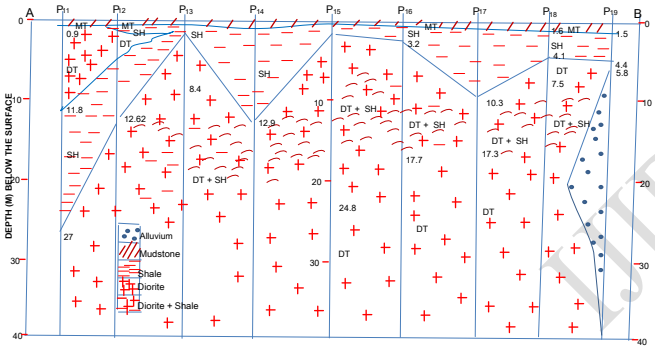

Figure 3: Geoelectric section along profile $P_{11} – P_{19}$

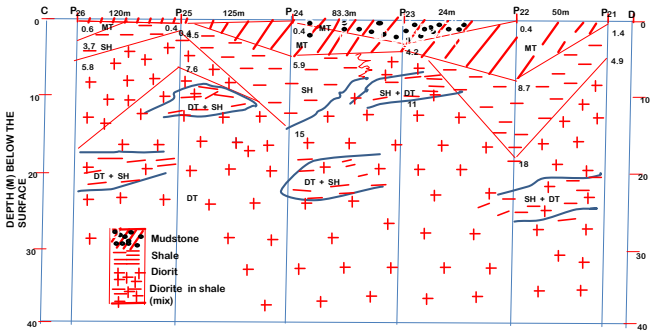

Figure 4: Geoelectric section along profile $P_{26} – P_{21}$

V. RESERVE ESTIMATION

With subsurface width of 140m, length of 330m and maximum thickness of 19m (modeled depth = 37m and maximum overburden of 18m), volume of rock matter is given by

Width x length x thickness
140 x 330 x 19
877800$m^{3.}$

Given an average density of 2.84 x $10^3$$kgm^{-3}$ and volume of rock matter as 877800m^3. Then, total mass of diorite/shale mix will be

877800 x 2.84 x 10^3
2492952000kg
2492952 metric tones
a. million metric tons

VI. CONCLUSION

The estimated reserve of 2.49 million metric tons with mean density of 2.84 x $10^3$$kgm^{-3}$ obtained from field data indicates diorite of significant quarry potentials in Amaubiri area. The absence of diorite outcrops on the surface is probably as a result of the great overburden. A quarry could be operated in the area but care must be taken to get rid of any pond development which may result in a situation where diorite occurs in isolated masses and sometimes with shale layers.

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