A DETAILED GEOPHYSICAL EXPLORATION REPORT TO GUIDE BOREHOLE DRILLING

FOR

OTOTO COMMUNITY

OFF KOBAPE ROAD
ABEOKUTA
OGUN STATE

FACILITATED BY:
ROTARY CLUB OF ABEOKUTA

SURVEY CONDUCTED BY:
ASHINGTON GEOCONCEPT LTD;
ABEOKUTA
08032408001

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INTRODUCTION

The report of a detailed geophysical survey for locating productive underground water for Ototo community, off Kobape road, Abeokuta, Ogun State; was awarded to *Ashington Geoconcept Ltd,* Abeokuta. Project facilitated by Rotary Club of Abeokuta. A geophysical site investigation was carried out on 4th of January 2024 along the established traverses.

Certain physical properties and parameters of subsurface formations and contained fluid are measured using by instruments located at the surface. The success of this method depends on how best the physical parameters deduced are interpreted in terms of hydrogeological language.

On regional broad assessment, the study area falls within the transition zone of southwestern Nigeria dominated by thick lateritic sequence, kaolin, iron formation, sandy layer and the basement complex.

Electrical resistivity method was employed for data acquisition with high accuracy and precision. The vertical electrical sounding, otherwise known as depth sounding was used to delineate vertical variation and this method is known to be schlumberger configuration. Vertical Electrical Sounding (VES), this gave a vertical continuity of the rock to a depth of about 150m, Pool finder and ADMT machine was use which produced a pseudo section to a depth of 300m.

The use of surface geophysics in evaluating the lithological sequence/units of an area is important not only in reducing the wild cat search through drilling but in locating the best probable point in an area thereby allowing for comparison and scientific guide to control the choice of location. Therefore, the geophysical investigation is employed to highlight the following **objectives**:

(i) to locate aquifers capable of yielding water of suitable quality
(ii) to determine the depths of aquifers with particular reference to the saturation zone
(iii) the type of rocks to be encountered
(iv) method to apply in drilling
(v) the geo-electric parameters of the area

Adequate precautionary measures were taken in the data collection on the field to ensure accuracy and minimize possible error. The interpretation of data collected from the field was processed using curve matching and computer iteration method for accuracy in the decision making.

CHAPTER TWO

2.0 GENERAL GEOLOGY/HYDROGEOLOGY

The Geology of Ogun State is partly divided into two major categories; the basement complex and the sedimentary area. On regional broad assessment, the study area falls within the transition zone of southwestern Nigeria dominated by thick lateritic sequence, iron formation, sandy layer and the basement complex.

In basement complex area groundwater are located within the weathered rock and or where fractured / fissures/ cracks occurs. The quantity of the water depends on a lot of factors, primarily the discharge, yield, storage and pressure. The quality of water in the basement complex is dependent on the host rock, but generally groundwater in the Basement Complex Area is usually of quality within the approved standard of WHO.

In this region of study the water is consumable water is usually located within the appreciable thick sand deposit, which is tagged the aquifer. On most cases, the thickness of the aquifer, porosity and permeability with the layer determines the yield of the borehole.

2.1 TOPOGRAPHIC LAND SURVEY

The use of compass and GPS were employed to assist in cutting grids across the study area. These grids allowed for detail surface and sub-surface mapping.

2.2 SITE LOCATION

The site is located at Ototo, off Kobape road, Abeokuta, Ogun state, Southwestern part of Nigeria.

2.3 ALTITUDE TOPOGRAPHY AND DRAINAGE

The major water occurrence in the area is a seasonal stream. The Elevation above sea level varies between 170 and 175 m in accordance with the GPS reading. The general drainage trends in the East-West direction.

CHAPTER THREE

3.0 GEOPHYSICAL INVESTIGATION

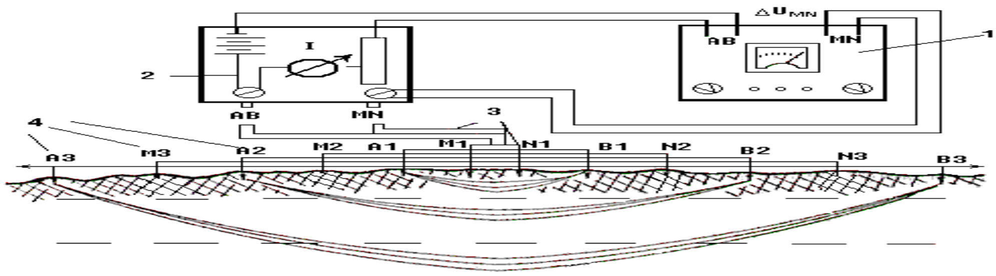
3.1 THEORY

There are various methods of geophysical survey that can be implored but the choice of electrical resistivity method was adopted because of the geology of the area and the accuracy of the method.Geophysical survey is the study of the variation in the value of the physical parameter of the crust of the earth with the objective of gaining information about the subsurface.

The Vertical Electrical Sounding and Electrical Profiling Methods are based on the four-electrode principle as shown in Fig. 1. The electrical current (*I*) is applied to A and B electrodes and the potential (ΔU) is measured between M and N electrodes. The bulk soil electrical resistivity (*ER*) is calculated with

$$ER = K\frac{\Delta U}{I}$$ …………….. Equation 1

where*K* is the geometric factor.



$$K = \frac{2\pi}{\frac{1}{[AM]} - \frac{1}{[BM]} - \frac{1}{[AN]} + \frac{1}{[BN]}}$$ ……………..Equation2

where [*AM*], [*BM*], [*AN*], and [*BN*] are the distances (m) between the respective electrodes. For central-symmetric array, when [*AM*]=[*BN*] and [*BM*]=[*AN*],

3.2 PROFILE

One profile was run using wenner array with electrode spacing of 30m. This allowed testing for physical lateral variation at depth 30m. This array consists of four electrodes in line, separated by equal intervals, denoted *a*. It is used to investigate lateral changes in apparent resistivity reflecting lateral geologic variability or localized anomalous features. From the data obtained, the best point for groundwater potential was picked on the traverse and the point was sounded.

3.3 SCHLUMBERGER ARRAY

The method investigate changes in resistivity with depth, the size of the electrode array is varied. The apparent resistivity is affected by material at increasingly greater depths as the electrode spacing is increased. Because of this effect, a plot of apparent resistivity against electrode spacing can be used to indicate vertical variations in resistivity. It was carried out with the current electrode distances (AB) being 200 meters. There was space constrain, which prevented us from a wider spread.

3.4 APPARENT RESISTIVITY

Wherever these measurements are made over a real heterogeneous earth, as distinguished from the fictitious homogeneous half-space, the symbol ρ is replaced by ρ_a for apparent resistivity. The resistivity surveying problem is, reduced to its essence, the use of apparent resistivity values from field observations at various locations and with various electrode configurations to estimate the true resistivities of the several earth materials present at a site and to locate their boundaries spatially below the surface of the site.

3.5 LONG RANGE WATER DETECTOR: This is an electromagnetic method that scans the presence of water in the subsurface. This device has the capacity of scanning 0m to 2000m deep and a front range of 1200m. It detects the present of water in the ground by calculating the percentage of Ca and Mg ions present in the water which can only be produced as a result of the interaction of rocks and water. It is a recent technology by Germany developed in 2015 to replace several traditional dowsing tools that has no scientific backings and to be more accurate in the field of ground water search.

CHAPTER FOUR

4.1 RESULTS AND DISCUSSION

This study provided a basis for using the vertical electrical sounding method in soil survey. The conventional VES method commonly used for deep geophysical exploration was modified to make it suitable for soil interpretation. The interpretation of the results revealed 4 layers of Consolidated lateritic clay deposit, kaolin, sandy formation, weathered basement, basement complex.

The VES sounding reveals fair yield aquifer in this area showing the top soil with resistivity value of 25 –61 Ωm and a thickness of 28.1 m above the subsurface; it is suspected to be lateritic sandyclay/kaolin/ hardpan. The second layer has a resistivity value 80.7Ωm with thickness of 21.2 m; it is suspected to be fresh basement. The third layer has a resistivity value 158 – 222 Ωm with thickness of 132.6m; it is suspected to be fractured basement complex. The third layer has a resistivity value of 120.3Ωm with an appreciable thickness. This layer is expected to be fractured basement complex.

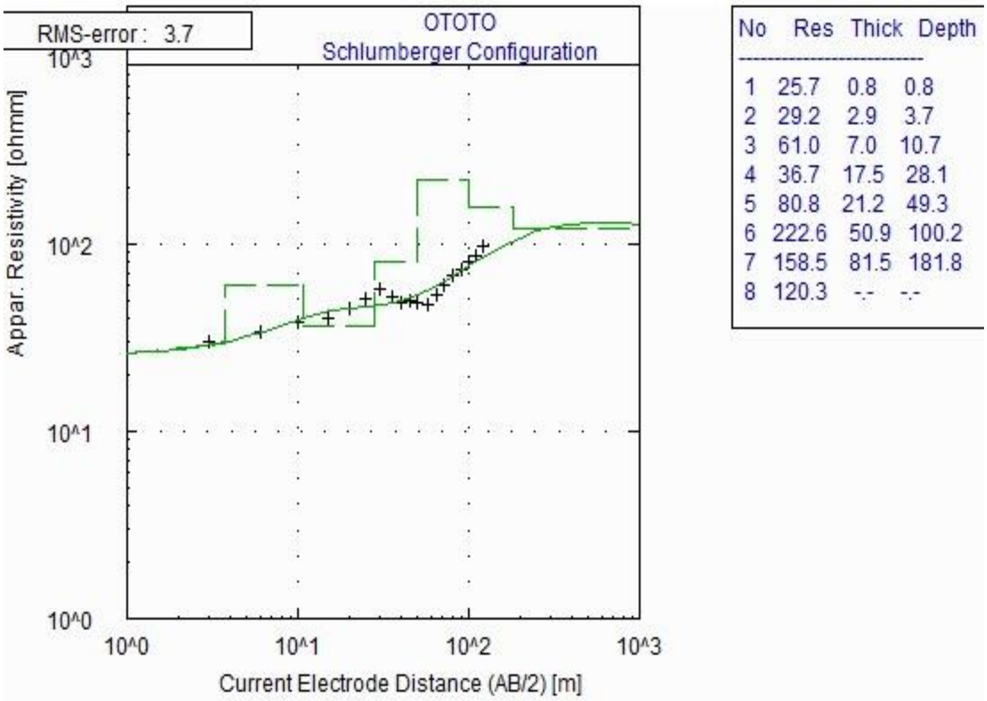
It is worthy to mention that electrical resistivity survey method simply identifies physical structures like fractures buried within the rock body. This method does not guarantee water occurence as the identified structure could be filled with ore bodies (conductive minerals) or dry.

The equipment used is not absolute and does not guarrantte the expected volume of water , it can only identify physical structures buried within the rock body. So, a geologist is therefore not liable for either the quality or quantity of the underground water obtained at the site as they are absolutely a function of nature.

INTERPRETATION OF VES DATA

S/N	RESISTIVITY (Ω/M)	THICKNESS (m)	DEPTH (m)	LITHOLOGY INTERPRETATION
1	25.7	0.8	0.8	LATERITIC CLAY
2	29.2	2.9	3.7	LATERITIC CLAY
3	61.0	7.0	10.7	LATERITIC CLAY
4	36.7	17.5	28.1	SAND GRADING TO BASEMENT COMPLEX
5	80.8	21.2	49.3	FRESH BASEMENT COMPLEX
6	222.6	50.9	100.2	MINOR FRACTURED BASEMENT COMPLEX
7	158.5	81.5	181.8	MINOR FRACTURED BASEMENT COMPLEX
8	120.3	--------	-------	MINOR FRACTURED BASEMENT COMPLEX

GRAPH FOR THE VES



RECOMMENDATION

- Based on the interpretation and the field observation and having correlated the data obtained with field observation, it is therefore recommended that a borehole be sunk at the location of the VES to a depth of about 90 - 100m.
- All aquifers encountered before getting to the recommended should be screened.
- The yield is expected to be fair
- Thorough gravel pack and grouting should be applied
- Treatment plant may be required depending on the water chemistry
- The VES point is characterized by hard and soft formation which may poise problem during drilling operation and drilling completion, a low pressure compressor can be applied to the hardpans before getting to the basement.
- A competent rig should be employed

EXECUTIVE SUMMARY

Area Geology:	Basement complex
Curve Type:	A
Expected yield:	Fair
Basement Stability:	Partially stable
Need for Inner casing:	May be required
Saturated zone:	52 – 120 m
Overburden:	25 m
Fracture zone:	Minor 52, 73 and 96 m
Nature of aquifer:	Overburden and fractured basement
Expected Drill Depth:	90 – 100 m
Adoptable Drilling method	Rotary and DTHH
Evidence of dry fracture:	Tendency

VES DATA

OTOTO

N07 08 34 E03 22 41

Schlumberger Array

AB/2	RES
1.0000	26.0000
3.0000	30.0000
6.0000	34.0000
10.0000	38.0000
15.0000	40.0000
20.0000	45.0000
25.0000	51.0000
30.0000	57.0000
36.0000	52.0000
40.0000	49.0000
45.0000	50.0000
50.0000	49.0000
58.0000	47.0000
65.0000	53.0000
72.0000	60.0000
80.0000	68.0000
90.0000	73.0000
100.0000	80.0000
110.0000	87.0000
120.0000	97.0000

PSEUDO SECTION USING ADMT