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RESISTIVITY SOUNDING SURVEY FOR THE DETERMINATION OF DEPTH TO WATER TABLE AT AMOKWE IN UDI L.G.A OF ENUGU STATE.NIGERIA

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ABSTRACT: Vertical electrical resistivity sounding was carried out in Amokwe in Udi L.G.A to determine the depth to water table in the area. When an external voltage is applied across any two electrodes inverted in the ground, it will be observed that current flows through the earth from one electrode to the other. The conductivity was chiefly determined by the characteristics of the subsurface formation. If the subsurface medium on which the current is passing is the same to its electrical properties, the path of the current flow will be regular while distortion in the flow of current occurs the subsurface medium is not the same to its electrical properties. In measuring the apparent resistivity ABEM TERRAMETER SAS 300B was used employing schlumberger electrode configuration, the data obtained from this job was interpreted using partial curve matching which helps the determination of the resistivities and the thickness of the earth layers at different depth beneath the surveyed area. It was also observed that the layers beneath the surveyed area can be described in four geoelectric layers.

KEY WORDS: Abem Terrameter, Resistivity, Sounding, Survey, depth to water level, schlumberger.

INTRODUCTION

As a result of the growing need for water, people involve themselves in drilling boreholes for domestic and industrial purposes: thereby leading to applying the five main methods of using the physical methods to locate treasures hidden under the earth; the -Seismic -gravity -Electromagnetic -magnetic -electrical (Griffiths and King 1981).

Others like chemical, thermal depending on what one is looking for. Generally, underground water lies and fills the pores of underground masses of rocks, they sediment quite like those we observe at the land surface and the water that temporarily flows on or below the surface of the ground generally available for water supply. Resistivity method depends on its operations of the fact that any subsurface variation in conductivity alters the form of current flow within the earth and this affects the distribution of electric potential. It measures the earth's resistances using the electric conductivity and widely used for structural study beds having greatly different resistances and particularly for determining the depth of flatly different formations and locations of water bearing formations (Dabrin M.B., 1976).

In spite of many prospecting methods that can be explained under the geophysical methods only the electrical and seismic methods have limited applications to underground water. In this work only the electrical resistivity method is employed using the ABEM TERRAMETRE applying the schlumberger electrode arrangement for resistivity determination. By applying surface investigation the detailed study of underground water condition is observed to determine the depth to water table at Amokwe in Udi L.G.A of Enugu State.

2. GEOLOGY AND LOCATION OF STUDY AREA.

The resistivity survey of underground water was carried out at AMOKWE in UDI LGA of Enugu State Nigeria and the area was found to lie between longitude 45°1'N and latitude 45°E from OBIOMA and also longitude 21°9'S and latitude 51°W from OBINAGU in UDI LGA of Enugu State Nigeria.

Fig 1. Showing the map of the study area.

3. PROCEDURE AND FIELD DATA ACQUISITION.

In carrying out the field work experiment for resistivity survey, equipment needed for the operation include, power source ,meters for measuring currents and voltages, electrodes, measuring tapes and wires. In view of this work the schlumberger electrode configuration was used as a result of its provision of a very long transverse measurement since the length of the spread determines the depth penetration.

4. THE EQUIPMENT.

The equipment used in carrying out this survey is the ABEM TERRAMETRE (model SAS 300B) and other accessories. The Abem Terrameter which is a battery

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powered deep penetration resistivity meter with an output sufficient for current electrode separation of about 2000m under good surveying condition. The instrument consists of three basis sub-units housed in a single casing with an electrically isolated transmitter for the supply of defined regulated single current. A microwave processor for monitoring, controlling and computation and finally a receiver for the dissemination and measurement of voltages correlated with the transmitted signal current (Wolman .A., 1969). Due to low frequency of the Abem Terrametre which is about 4c/s, it is used for the greater depth investigation and hence it is as far more portable as most instruments used in resistivity work based on a transistorized electronic circuit, it has a maximum output of 6w and areas of resistance range 0.01 to 10,000Ω.

Fig 2. Diagram of the equipment.

After setting the instrument as required the centre point of the sounding station was first marked out, from this point half the distance between the potential electrode MN/2 was measured and marked on the either side of the centre point using the measuring tape. At this point the separation of the current electrode AB/2 were also measured and marked, with a hammer the potential and current electrode a strong metallic conductor rod about 60cm long was driven into the ground about ¼ of the length, afterwards the electrodes were connected to the Abem Terrameter using the current and potential cables. The equipment was switched on after adjusting the current, potential cables, and cycle knobs to the desired values.(Abem 1977) The measured button was pressed and the equipment displays the value of ΔV/I it calculated which is thus read and recorded. The current electrode separation is increased with the potential electrode separations kept constant and the value of ΔV as displayed by the equipment was taken. The potential electrode separation is increased to allow for deeper penetration and better results. This process is called looping which means repeating reading for two already occupied current electrode positions with the new potential electrode spread.

Table 1. Showing spread chart of electrode separation used for the field work.

AB/2 (m)	MN/2 (m)
1.5	
2.0	0.5
2.5	
3.5	
4.5	
6.0	
8.0	
10.0	
15.0	
10.0	
25.0	
20.0	
25.0	3.5
35.0	
45	
55	
45	
55	
75	
95	
125	
165	
215	14

5. Computation of ρ_a and Ks.

The data as obtained from the field is shown above, the apparent resistivity ρ_a is computed using the formula.

ρ_a = $(a^2/b \;\; b/4)R$.

where a = half the distance between current electrodes given as AB/2 in the data sheet.

b = the distance between the potential electrode given as 2(MN/2) or

b = MN as in the data sheet.

R = the resistances given by the terrameter at different separations as ΔV/I.

The term (a2/b b/4) represents the geometric factor ks thus the apparent resistivity ρ_a can be given as ρ_a = ks.R.

Table 2. Data sheet for survey area.

Reading Number	AB/2	MN/2	Ks	R	ρ_a
1	1.5		6.28	413	2593.6
2	2.0		11.78	196.9	2321.5
3.	2.5		18.84	119.8	2257.0
4	3.5		37.68	68.4	2577.3
5	4.5	0.5	62.8	52.1	3271.9
6.	6.0		112.3	28.1	3155.6
7.	8.0		200.0	15.30	3060.0
8.	10.0		313.21	10.35	3241.7
9.	15.0		705.71	3.80	2681.7
10.	10.0		39.36	83.7	3294.4
11.	25.0		95.43	28.5	2719.8
12.	20.0		173.98	16.75	2914.2
13.	25.5	3.5	274.86	10.50	2886.0
14.	35		544	4.20	2884.8
15.	45		908.36	3.20	2906.8
16.	55		1352	2.25	3042.0
17.	45		205.1	21.0	4307.1
18.	55		317	16.87	5347.8
19.	75		608.82	11.70	7123.2
20.	95	14	991	8.45	8374.0
21.	125		1730	10.05	17386.5
22.	165		3030	6.19	18955.7
23.	215		5161.82	4.50	23228.2

6. INTERPRETATION, RESULTS AND DISCUSSION

The field data obtained from the field work is plotted in a log-log graph from the schlumberger electrical sounding data sheet on which master and auxiliary curves were used for matching and interpretation of the field curves. The field data curves were superimposed over these set of theoretical curves and axis properly aligned keeping both axis parallel until the best fit on the theoretical curves is found from the field curve (Basko 1993). On obtaining the best fit curves, a cross (+) called the theoretical cross was marked on the transparent paper. The origin of the theoretical curve ρ_1 is noted as well as the resistivity ratio ρ_4 $\rho_{1.}$ the resistivity of the second layer and its thickness were determined by placing another matching curve at the point of inflexion and moving it vertically up and down the point of inflexion until the best fit is found (Koefoed. O., 1976). Again a theoretical cross (+) was then marked on the transparent paper to correspond to the origin of the matching master curve. The resistivities ρ_1 and the thickness h1 obtained at ρ_1 which corresponds to the resistivities and the thickness of the first layer are as follows (Telford 1976).

The thickness of the 5th layer was underdetermined, summarily, it was observed that the depth to water table at Amokwe in Udi local Government is 11.35m by summing the total heights h1 + h2 +h3 + h4 = 0.55 + 2.3 + 3.7 + 4.8 = 11.35m.

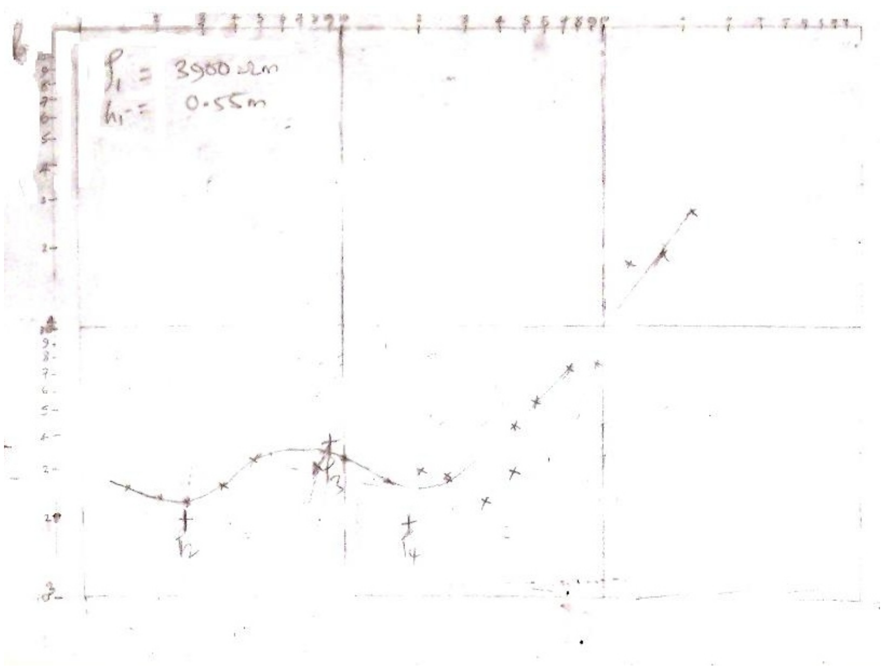

Fig. 3 a log-log graph showing the interpretation of the field curves.

Table 3. Summary of the apparent resistivity value and the thickness of the electrode spacing.

Apparent Resistivity (Ωm)	Thickness (m)
ρ_1 = 3900Ωm	h_1 = 0.55m
ρ_2 = 7/3 $\rho_2 = \frac{3900 \times 7}{3}$ = 9100 Ωm	$h_2/h_1 = 4.2$ h_2 = 0.55 x 4.2 = 2.3m
$\rho_3/\rho_2 = 9$ ρ_3 = 9100 x 9 = 81,900 Ωm	$h_3/h_2 = 1.6$ h_3 = 2.3 x 1.6 = 3.7m
$\rho_4/\rho_3 = ¼$ $\rho_4 = \frac{81{,}900 \times 1}{4}$ = 20475Ωm	$h_4/h_3 = 1.3$ h_4 = 3.7 x 1.3 = 4.8m
$\rho_5/\rho_4 = 19$ $\rho_5 = \frac{20475 \times 1}{19}$ = 1077.6 Ωm	

7. DISCUSSION

The aim of this research work was to determine the depth to water table at Amokwe in Udi L.G.A of Enugu State, the field curve obtained shows a characteristic H- curve (low-high-low) and the interpretation of the curve using a set of master curves, auxiliary curve gave the depth to water table at this locality to be11.35m. It was also observed that there is no clear cut in the resistivity ranges corresponding to different minerals but if a layer exhibits high resistivity, then the layer could have dry sand stones or fresh water content. If in the medium range, it could suggest a layer composed of porous sand stones and water bearing layers (aquifers) while low values of resistivities could suggest the presence of clay and fine grain materials. Permeable beds lie within 568Ωm and this has the perched aquifer (David D., 1996). From the data, the surface measurements has been done with great care and thus declared accurate. So with reference to depth variation one can conclude that citing a borehole at Amokwe is economically less expensive.

8. CONCLUSION

As regards ground water investigation, it is crystal clear that the ground layer of Amokwe is sand stone and thus capable of providing water for the community and the rural populace (Ferzaghi. K and Peck. B 1970). The water table is at a depth of 11.35m from the surface but any borehole to be dug must be deeper than that value because of the depth of saturation to ensure good recharge. From the geology of the area, it has a good permeability and there is also a high average annual rainfall in the area.

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