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Geophysical Solution to Lack of Drinkable Water in Standard Secondary School, Abakaliki, Nigeria

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ABSTRACT

Lack of portable water has been a problem in many parts of Abakaliki metropolis. The geophysical resistivity method (Schumberger configuration) was used to determine the depth at which underground water could be located in Standard Secondary School, Abakaliki so as to exploit same to meet the water needs of the students. The equipments used were ABEM terrameter, four electrodes, hammer, cables and measuring tape. Five layers of the earth were delineated. The resistivity values from the first layer to the fifth layer were 1132.70Ωm,521.47Ωm, 752.73Ωm, 160.34Ωm and 109.66Ωm respectively. The thicknesses of the layers were 1.1m, 3.2m, .2.7m , 12.8m and an undetermined depth from the first to the fifth layer respectively. The fourth layer, which has low resistivity and which is also composed of fissile shale (fractured), has the best prospect for groundwater formation. Its depth is approximately 20m.

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INTRODUCTION

In the past, residents of different areas within Ebonyi State depended wholly on surface water such as streams, ponds and lakes for their every day supply of water which usually dries up at dry seasons. This was due to one main reason which is not far-fetched; it was due to the fact that there was no modern technology to provide an alternative to surface water supply. Today, the reverse is the case. Increased activities from small scale industries, homes, abattoirs etc has drastically polluted the surface waters and rendered it unfit for use of which consumption is among. Unfortunately, this is the only available source despite increased demand for potable water due to increase in population within the last few years. The population of Abakaliki metropolis is 141,438 (NPC, 2006). Another disturbing scenario in Abakaliki Metropolis is that environmental pollution arising from unsustainable waste management practices in the metropolis. Current reports in the literature (Nwofe, 2013a), indicate that the average volume of solid waste generated in Abakaliki Metropolis on daily basis is known. The average volume of waste per capita per day is 9.580 x 10-3 m3. Other research groups have also reported on unsustainable waste management practices and its impact on the environment in Ebonyi State and other parts of Nigeria (Ngouakam *et al*., 2012; Nwoke 2013; Nwofe 2103b-c).

However, with recent technological development, groundwater is the choice for domestic and industrial use. A better knowledge of the aquifer formation and characteristics (confined or unconfined) in this area is therefore important so as to ascertain whether the aquifer is prone to contamination or not. To achieve this, hydro-geological and geophysical studies are necessary in this area. Hence this study is carried out to establish a baseline geophysical data and hydrological characteristics using the vertical electrical sounding (VES) of resistivity surveying. The choice of this method was based on the fact that the instrumentation is simple; field logistics are easy and straight-forward while the analysis of data is less tedious and economical (Kearey and Brooks, 1991; Dobrin, 1976; Lowrie, 1997; Kogbe, 1989). The resistivity method has been successfully used in investigating groundwater potential in different geophysical settings. Agha and Nnabo (2013) used the method to study the subsurface lithology of Nkwegu, 20km south of Abakaliki. Their maximum current electrode spread was 300m. The result of their study showed that the average resistivity and thickness of earth layers in Nkwegu from the surface are 917.64 and 1.3m for the first layer, 138.89 and 8.8m for the second layer and 480.82 and 17.9m for the third layer indicating that the layers were probably made of lateritic overburden, wet ferruginised clay and fissile shale accordingly. In the literature, Odo (2010), Odo *et al* (2012), have

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reported on the use of azimuthal resistivity survey to determine the characteristic fracture patterns and porosity of a subsurface fractured shale, compared the determined orientations to those obtained from surface outcrop fracture map within Kpiri Kpiri in Abakaliki metropolis, with a view to integrate the results for selected borehole performance test and groundwater head contouring within the study area (Kpiri Kpiri in Abakaliki metropolis). Ben and Onwuemesi (2009), also worked on the estimation of anisotropic properties of fractures in Presco campus of Ebonyi State University Abakaliki, Nigeria using Azimuthal resistivity survey method. In this study, the use of geophysical resistivity method (Schumberger configuration) to determine the depth at which underground water could be located in Standard Secondary School, Abakaliki, Ebonyi State, is reported.

Methodology:

Resistivity survey equipment is designed to measure the resistance of the ground to a very high accuracy. Apparent resistivity values are completed from the resistance measurement using the formula relevant to electrode configuration in use. The Schlumberger electrode configuration was employed and vertical electrical sounding (VES) was adopted and used as a basis of inferring the vertical succession of different conducting zones/geoelectrical sections within the subsurface. One of the ends of the cables was connected to the output of the terrameter while the other ends were connected to the steel electrodes (the potential and current electrodes). The terrameter was stationed at a point (sounding station) and the steel electrodes were expanded along a straight line (profile line). The potential electrodes M and N were placed 0.5m away from the sounding station on both sides. Likewise the current electrodes are spread at both sides but farther than the potential electrodes. Direct current (d.c) of very low frequency was then introduced into and received from the ground through two steel electrodes A and B respectively. This caused a potential difference (p.d) to be set up which was measured between the other pair of steel electrodes M and N. The four electrodes A-M-N-B are kept in a straight line such that AB <5MN (for the schlumberger array).

The generalized configuration of the Schlumberger arrangement is given in Fig. 1.

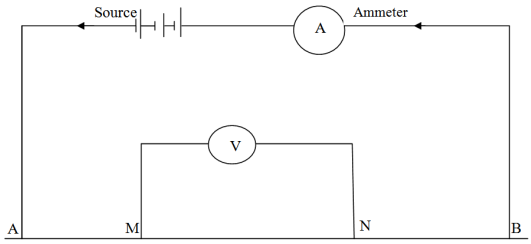

Fig. 1: Generalized configuration of the Schlumberger array.

Results:

Ves Data And Analysis:

The vertical electrical sounding(VES) data of the resistivity survey carried out in the study area are shown in Table 1 while the interpretation of the results from the study area is shown on Table 2.

Table 1: VES data from the study Area (truncated).

Survey point	Current electrode spacing	Potential electrode spacing	Geometric factor, K	Resistance (R)	Apparent resistivity, (ρ_a)
1	1	0.2	7.536	141.3	1064.8
2	1.5	0.2	17.3485	40.38	700.58
3	2	0.2	31.086	17.17	533.68
4	3	0.2	70.336	6.692	470.99
5	3	0.2	27.475	17.54	481.95
6	5	0.5	195.936	2.453	480.64
7	5	0.2	77.715	6.226	483.83
8	7	0.5	153.075	2.828	432.88
9	10	0.5	313.215	1.567	490.81
10	15	0.5	705.715	0.741	522.62
11	15	0.5	137.375	3.845	528.25
12	20	2.5	1255.215	3.416	522.62
13	20	0.5	247.275	2.155	532.76
14	30	2.5	561.275	0.804	451.39
15	40	2.5	1000.875	0.366	366.13
16	50	2.5	1566.075	0.19	296.99
17	50	10	376.8	0.83	312.81
18	60	2.5	2256.875	0.124	278.91
19	60	10	549.5	0.52	285.5
20	70	10	753.6	0.355	267.47
21	100	10	1554.3	0.131	203.75
22	120	10	2245.1	0.082	183.5
23	150	10	3516.8	0.034	120.73
24	200	10	6264.3	0	0

The apparent resistivity values were plotted against half the current electrodes separation(AB/2) on a log-log plot using computer software. The resulting graph is shown in Fig. 2.

Table 2: Interpretation of results from Study Area.

Layer	Depth	Thickness	Resistivity, ρ_a	Lithology
1	1.10	1.1	1132.70	Loose but lateritic overburden
2	6.92	3.2	521.47	Ferruginized clay concretions
3	15.33	2.7	752.73	Limestone bed (probably dry)
4	36.70	12.8	160.34	Fissile shale (Likely fractured and wet)
5	Base not reached		109.66	Compact mudstone (Probably wet)

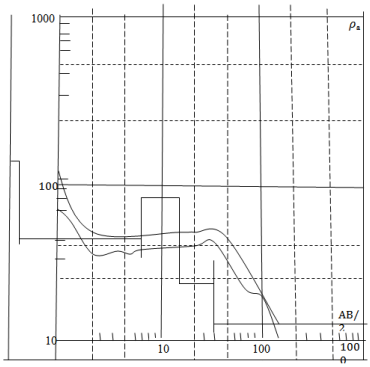

Fig. 2: VES curve of data from study area.

Discussion:

From Fig. 2, the layer resistivities are observed to vary greatly. The first and third layers have high resistivity showing absence of water. The second layer is the wet zone. It may contain small quantity of water, which may not be of economic value. The resistivity of the fifth layer is inferred to be composed of mainly mudstone. The layer seems to be saturated with water but the water might be rich in dissolved mineral ions hence rendering it undrinkable. The fourth layer proves to be the most promising bed. The water here is hosted in the fractured zone, hence when this fractured zone is intercepted by the drilling of borehole, water flows from the fractured zone into the well. This is due to the low porosity and permeability of the rock. Details of the resistivity and thickness values of the subsurface layers delineated by the current and their lithologic interpretations are shown in Table 2.

Conclusion:

From the fore-going, it was concluded that:

(i) Groundwater can be assessed in the study area

i) The water is hosted in the fractured zones of the formations

ii) The fourth layer in the study area with resistivity 160.34Ωm has the best prospect of yielding portable ground water.

iii) The depth range at which ground water could be located is between 7.0 to 20.0m

iv) The resistivity method of geophysical exploration is suitable for groundwater investigation and hence provides a solution to the water problems of students of Standard Secondary School in particular and to the residents of Abakaliki in general.

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