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ELECTRICAL RESISTIVITY INVESTIGATION OF THE GROUNDWATER POTENTIAL IN OLORUNTEDO COMMUNITY, ABEOKUTA, OGUN STATE, NIGERIA

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Abstract: Groundwater is that water found beneath the surface of the earth which serves as a predominant source of water for human endeavours. The aim of the study was to determine viable aquiferous zones to investigate the groundwater potential using resistivity technique (specifically Vertical Electrical Soundings) in Oloruntedo Community Obantoko, Odeda Local Government area, Abeokuta, Ogun State. The highly resolution PASI Earth resistivity meter, Model 16 GL geophysical equipment was used to acquire the groundwater location. Relatively six (6) Vertical electrical soundings were carried out via Schlumberger array. The VES data generated were processed and interpreted using partial curve matching method and computer iteration techniques. The result shows four geo- electric sections with varied thicknesses and resistivity. The resistivity of the top soil ranges between 181 ohm-m and 1460.6 ohm-m, the resistivity of clay varies between 31.8 ohm-m and 789.8 ohm-m, the resistivity of the fresh basement ranges from 1049.3 ohm-m and 8961.5 ohm-m which was the only layer observed in one of the (6) VES points. The resistivity of weathered basement ranges from 90.6 ohm-m and 388.2 ohm-m, the resistivity of highly weathered ranges from 13.6 ohm-m and 49.1 ohm-m and lastly the resistivity of the lateritic sand which was only observed in one of the (6) VES points is 294.4 ohm-m. The results show that a drilling depth of 50m is feasible at VES 6, 40m depth borehole at VES 4 and 5, while 20m depth borehole at VES 1, 2 and 3 respectively is feasible in the study area. VES 6 station has the highest groundwater potential, secondly by VES 4 and 5 while VES1, 2 and 3 imprint a low groundwater zone in the study area. The study confirms that Electrical resistivity technique is a good method in identifying groundwater potential zones in an area.

***Keywords*: Groundwater, Groundwater potential, Electrical resistivity, Vertical Electrical Sounding, Schlumberger array.**

INTRODUCTION

Groundwater is one of the most important environmental reserves exploited for industrial, agricultural, and domestic uses (Wagh *et al.*, 2016). At least, one-third of the global population rely on groundwater for drinking (Panaskar *et al.*, 2016). It can be abstracted by drilling boreholes and hand-dug wells within the permeable geological formation (Taiwo *et al.*, 2016).

The electrical resistivity method involving the Vertical Electrical Sounding, (VES) technique is extensively gaining application in environmental, groundwater and engineering geophysical investigations (Afolayan and Olorunfemi 2004, Abubakar and Auwal 2012, Adepelumi *et al.*, 2013, Ochuko 2013, Okogbue and Omonona 2013, Oladunjoye *et al.*, 2013, Akande *et al.*, 2016, Bienibuor *et al.*, 2016, Kumar *et al.*, 2016, Nicholas *et al.*, 2016).

The need for groundwater geoelectric investigation in the study area has aroused due to the fact that most of the drilled boreholes are done without any detailed and deep field hydrogeologic mapping and preliminary geophysical investigation as confirmed from the community except for few boreholes in the study area, and this problem has resulted to failures of some boreholes. This failure has led to drying up of wells, land subsidence, deterioration of water quality, increase in pumping cost and reduction of water in streams and lakes. Several deep wells (boreholes) drilled and development within the study area have failed because of poor siting of the boreholes emanating from poor understanding of the geology and groundwater occurrence in the area. Considering the high cost of drilling as well as time wasted and high rate of unproductive borehole, there is need for precision and accuracy before embarking on borehole drilling. Also geophysical methods in groundwater exploration are important in order to understand the hidden subsurface hydrogeological conditions accurately and adequately.

RESEARCH METHODOLOGY

The study area is Oloruntedo Community, Odeda Local Government Area of Ogun State. Geographically the area lies between latitude 7º 11´ 46.5″ N and 7º 11’ 28.50″ N and longitudes 3º 23´ 13.8″ E and 3º 23´ 4.5″E. Abeokuta is located in Ogun State, Southwestern Nigeria, as shown in Figure 1 The area lies predominantly in a basement complex of South-western Nigeria, which are featured by rocks of mainly Precambrian age.

The area is located within a region characterized by a bimodal rainfall pattern (commencing in March; plentiful in July and September, with a short dry spell in August). The mean diurnal minimum temperature varies from 21.80ºC in December to 24.34ºC in April while the mean diurnal maximum temperature varies from 33.92ºC to 37.1ºC at the onset of the wet season (March and April) (Akanni 2000).

The method used for this research work is in three (3) folds, which includes, Data

Acquisition, Data Processing and Data Interpretation respectively.

Data Acquisition

The highly resolution PASI Earth resistivity meter, Model 16 GL geophysical equipment were used to acquire the data on field. Relatively six (6) Vertical electrical sounding were carried out via schlumberger array.

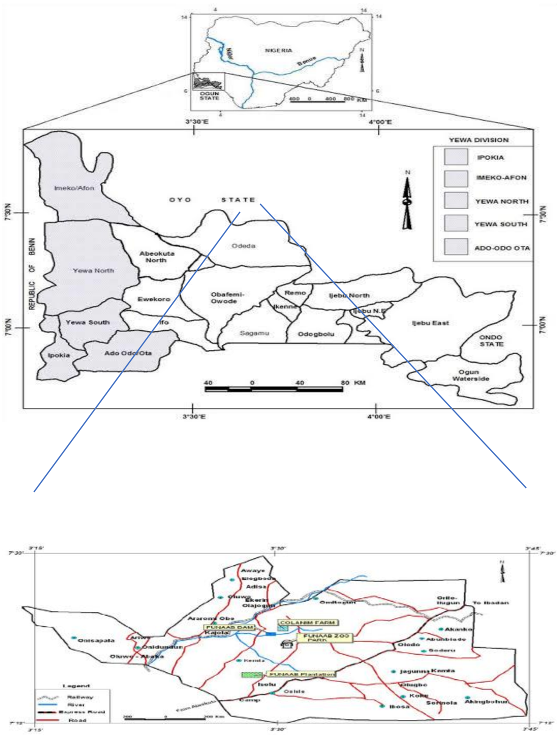

Figure 1: Map of the study area

The following accessories were also used during the data acquisition namely: Geological hammer, 4 Reels of Multi-Core cables, 4 steel electrodes and Crocodile clipped connector cable, 2 Connector, 12V, 60Ah Battery, GPS (Global Positioning System).

Data Processing

From the VES data acquired, the apparent resistivity measurements at each station were plotted against half-current electrode spacing (AB/2) on bi-logarithmic graph sheets, using a transparent tracing paper superimposed on the log-log paper. The curves obtained were matched using master curves and auxiliary curves. The curves were inspected to determine the number and nature of the layering. Partial curve matching was carried out for the quantitative interpretation of the curves. The results of the curve matching (layer resistivities and thicknesses) were fed into the computer as a starting model in an iterative forward modeling technique using WinRESIST Software, version 1.0 to model the subsurface groundwater condition in one dimensional (1D) view. This is to vindicate the correlation of the field curve and the theoretical curves and from the interpreted results (layer resistivities and thicknesses); geoelectric section of each of the VES points was drawn based on the interpretation of the resistivity data using Microsoft Office Excel.

Data Interpretation

The values of the true resistivities obtained from the iterated model for VES data, and the corresponding thicknesses were used to infer the suspected lithology, conforming to the basic rules as stated by Loke, 1999. The resistivity value and the geology of the area were used to infer the probable lithology during analysis of the data. The geological material in the subsurface at a given lateral distance and depth on the section was identified by locating its depth on the depth axis and the resistivity signature on the profile was used to infer the kind of material present.

RESULTS AND DISCUSSION

Figure 2,3,4,5,6 and 7shows the result of the VES presented as bio log plot with obtained apparent resistivities on the ordinates and half current electrode on the abscissa.

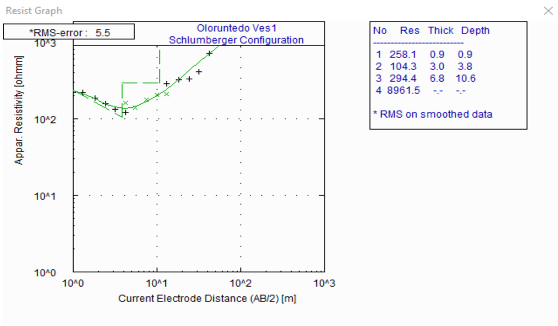

Figure 2: VES 1

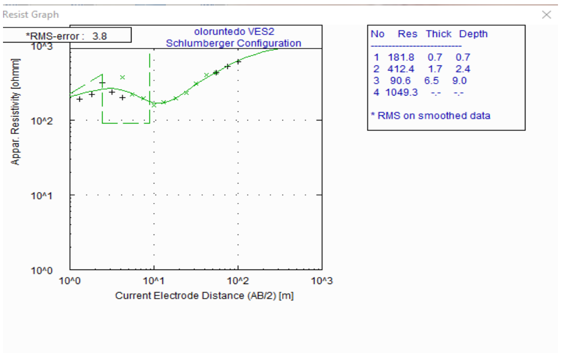

Figure 3: VES 2

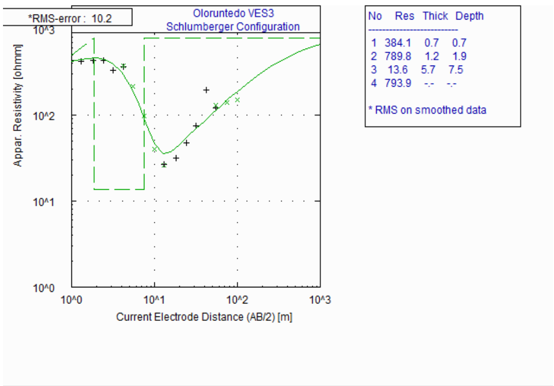

Figure 4: VES 3

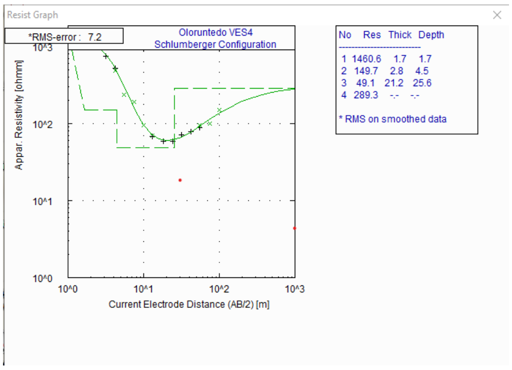

Figure 5: VES 4

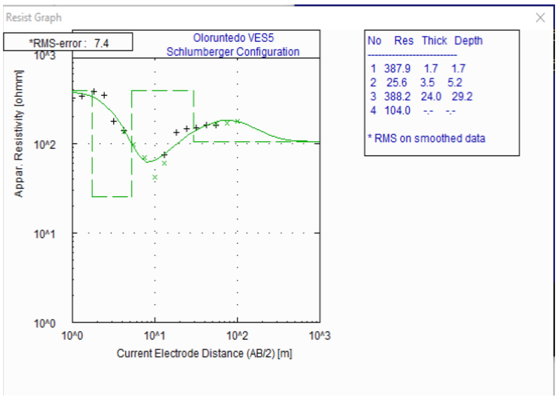

Figure 6: VES 5

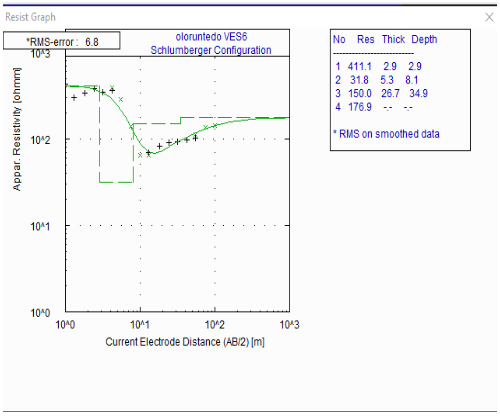

Figure 7: VES 6

Table 1 shows the summary of the layers parameters of the six VES points.

Table 1: Summary of layer parameters

VES NO	Number of Layers	Resistivity (Ohm-m)	Thickness (m)	Depth (m)	Type of Curve	Inferred Lithology
1	1	258.1	0.9	0.9	A	Top soil
	2	104.3	3.0	3.9		Clay
	3	294.4	6.8	10.7		Lateritic Sand
	4	8961.5	--	--		Fresh Basement
2	1	181.8	0.7	0.7	KH	Top soil
	2	412.4	1.7	2.4		Clayey Sand
	3	90.6	6.5	9.0		Weathered Basement
	4	1049.3	--	--		Fresh Basement
3	1	384.1	0.7	0.7	H	Top soil
	2	789.8	1.2	1.9		Clayey Sand
	3	13.6	5.7	7.5		Highly Weathered

	4	793.9	--	--		Fractured Basement
4	1	1460.6	1.7	1.7	H	Top soil
	2	149.7	2.8	4.5		Clayey Sand
	3	49.1	21.2	25.6		Highly weathered
	4	289.3	--	--		Fractured Basement
5	1	1460.6	1.7	1.7	H	Top soil
	2	149.7	2.8	4.5		Clayey Sand
	3	49.1	21.2	25.6		Highly weathered
	4	289.3	--	--		Fractured Basement
6	1	387.9	1.7	1.7	H	Top soil
	2	25.6	3.5	5.2		Clay
	3	388.2	24.0	29.2		Weathered Basement
	4	104.0	--	--		Fractured Basement

Six (6) detailed VES were carried out in the study area and interpreted quantitatively and qualitatively. The interpretation of VES conducted in the study area reveals the presence of four (4) geo-electric layers and these geo-electric layers fall into four groups and they are namely; top soil, clay, lateritic sand, fresh basement, fractured basement, weathered basement, highly weathered.

The resistivity of the top soil ranges between 181 ohm-m and 1460.6 ohm-m while the thickness ranges from 0.7m and 2.9m and the depth varies from 0.7m and 2.9m. The resistivity of clay varies between 31.8 ohm-m and 789.8 ohm-m while the thickness ranges from 1.2m and 5.3m and the depth ranges from 1.9m and 8.1m. The resistivity of the fresh basement ranges from 1049.3 ohm-m and 8961.5 ohm-m which was the only layer observed in one of the (6) VES points. The resistivity of the fractured basement ranges from 150 ohm-m and 793.9 ohm-m while the thickness is 26.7m and depth is 34.9m. The resistivity of weathered basement ranges from 90.6 ohm-m and 388.2 ohm-m while the thickness ranges from 6.5m and 24.0m and the depth ranges from 9.0m and 29.2m. The resistivity of highly weathered ranges from 13.6 ohm-m and 49.1 ohm-m while the thickness ranges from 5.7m and 21.2m and the depth ranges from 7.5m and 25.6m. And lastly the resistivity of the lateritic sand which was only observed in one of the (6) VES points is 294.4 ohm-m, thickness is 6.8m while the depth is 10.7m.

The first layer of all VES is generally top soil, is usually lateritic and sandy, the second layer under these VES (2, 3, 4) are made up of clayey and clayey sand and clay sand which are VES (1, 5, 6), the third layer of VES (2, 3, 4, 5, 6) are made up of fractured basement, weathered basement and highly weathered, except for VES 01 which is made up of lateritic sand, while the fourth layer of VES are made up of fractured and fresh basement.

However, groundwater potential in the study area has been strictly based on the geoelectric survey carried out with a careful assessment of boreholes and hang dug wells coupled with hydrogeologic nature of the study area. The results show that a drilling depth of 50m is feasible at VES 6, 40m depth borehole at VES 4 and 5, while 20m depth borehole at VES 1, 2 and 3 respectively is feasible in the study area. VES 6 station has the highest groundwater potential, secondly by VES 4 and 5 While VES1, 2 and 3 imprint a low groundwater zone in the study area.

From the study area weathered and fractured basement constitute aquifer units and its generally thick and its thickest at vertical sounding (VES) 3,4,5,6 and making those stations relevant for groundwater development in that area.

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The occurrence of high annual rainfall which provide recharge to the aquifer and the occurrence of thick aquifer in term of the weathered and fractured basements are responsible for the existence of good groundwater prospect in that area.

CONCLUSIONS AND RECOMMENDATION

The Vertical Electrical Sounding of this research have been used to Investigate the groundwater potential using resistivity technique in Oloruntedo Community Obantoko, Odeda Local Government area, Abeokuta, Ogun State.

Four geoelectric sections were recognized in this study area namely; top soil, clay, lateritic sand, fresh basement, fractured basement, weathered basement, highly weathered.

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According to the research, the following insinuation for groundwater exploitation in the study area may be functional;

- The most feasible station produce groundwater for industrious and municipal purposes are VES 4, 5 and 6 and should be set out for borehole drilling.
- Drilling should not be more than 50m because the study area falls between basement topography.
- Dumpsites should be cited far away from usable aquifer units and VES stations with weak aquifer protection capacity to avoid subsurface water from being contaminated in order to guarantee safe consumption of groundwater in the study area.

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