Journal of the Nigerian Association of Mathematical Physics
***Volume* 25 (November, 2013), pp 221 – 226**
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A Search for Aquifers in Crawford University, Faith City, Igbesa, Ogun State.

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Abstract

A resistivity survey was carried out in order to study groundwater conditions (such as the depth of aquifer) in Crawford University, Faith City, Igbesa. Three (3) vertical electrical soundings using Schlumberger array were carried out at different locations. The Schlumberger resistivity soundings were carried out with half- spacing in the range of 1- 178.00m.The resistivity data were used to determine the depth and nature of the aquifer, and they confirmed that the aquifer in Crawford University is mainly sedimentary.

***Keywords*:** Electrical Resistivity Soundings, Water Formation, Aquifer, Groundwater.

1.0 Introduction

The purpose of this paper is to use resistivity data and interpreted geoelectrical soundings to study aquifer conditions such as depth and nature, in a particular area of Crawford University. The study can also help to make projections for groundwater supplies in the area.

For decades, the use of geophysics for both groundwater resources mapping and for water quality evaluations has increased dramatically. The vertical electrical sounding (VES) has proved very popular with groundwater studies due to simplicity of

the techniques. Traditional method for characterizing layers include test hole drilling and analysis of log, the objective being to characterize the thickness and / or lateral extent of the protective layer. Disadvantages of such investigation are that they can be labour- intensive and expensive. A group of geologists [1] in their exploits examined the geochemical composition of groundwater quality in this community that habour Crawford University.

2.0 Geology of the study area

Crawford University, Faith City, Igbesa, Ogun State is situated within longitude N06^0 35$^/$ and N06^{0}36$^/$ and latitude E003^0 04$^/$ and E003^0 05$^/$ in Ado Odo/Ota local Government Area, Ogun State, Nigeria.(Figure 1). The study area forms part of the Dahomey (Benin) basin, a very extensive sedimentary basin on the continental margin of the Gulf of Guinea, which extends from the Volta River Delta, Southeastern Ghana in the West, to the Western flank of the Niger Delta [2, 3]. This Formation known as coastal plain sand is made of poorly sorted sands which are in parts cross- bedded and shows transitional to continental characteristics like Ilaro and Abeokuta Formations. The thickness of the coastal plain sand ranges from 10m from 100m while the ages fall under Pleistocene and Oligocene [1]. Despite several published works on the stratigraphical and paleontological aspects of the Southern Nigeria [3 - 5], unresolved controversies still surround the nomenclature, type section, and superposition of many rock stratigraphic units particularly in the Paleogene of Southwestern Nigeria.

The sedimentary basin in the Southern Nigeria is partially divided into Western and Eastern portions by the Okitipupa ridge a submarine basement whose outcrop approaches 40km of the coast at about $4^0 30^/ E$. In the Western part of the basin, sedimentation did not begin until the terminal stages of the Cretaceous whereas, the earliest transgression in the Eastern part was during the Albian. Tertiary sediments accumulated in the eastern half of an extensive Mesozoic-Cenozoic coastal basin which extends from Ghana in the west to Cameroun in the east. Marked variations existed in the texture and thickness of about 10,000 to 12,000 metres beneath the shelf of the Niger Delta [6] .

The Paleocene sea covers the Southern Nigeria extending entire westward to Republics of Benin and Togo. The Paleocene deposits are characterized by extremely rapid lateral facies changes. In Eastern Nigeria, the strata are large,

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composed of dark grey, thinly laminated friable Imo shale with occasional admixture of clay ironstone and sandstone beds. To the west, biogenic limestone of the Ewekoro Formation are found in the lower part of the Paleocene section [1]. The Paleocene deposits in Western Nigeria were attended by local crustal elevation which resulted in intensive erosion of the upper units of the limestone. Glauconitic shale and Phosphatic materials accumulated on the surface of the limestone.

3.0 Methodology

Vertical Electrical Soundings (VES) were carried out in the study area with an ABEM TERRAMETER SAS (Signal Averaging System) 3000B with booster SAS 2000 manufactured in Sweden was used for taking surface resistivity readings. The equipment is light and powerful for deep penetrations. The resistivity survey was completed with three sounding stations. The VES was conducted by using the schlumberger array (AB) ranging from 2 metres to 356 metres (AB/2 was 1 – 178m). The field data acquisition was generally carried out by moving two or four of the electrodes used between each measurement [7].

The VES of the three sounding stations were obtained by plotting the calculated apparent resistivity against electrode spacing. Computer programs for reducing geoelectrical sounding curves into thickness and resistivity of individual layer were applied. The field curves were interpreted by the method of curve matching. The field curve and the result of the curve matching were then subjected to computer assisted iterative interpretation. The end result of the field measurement is the computation of the apparent resistitivity, using the equation

$$\rho_a = \frac{KV}{I} = KR \tag{1}$$

where

$$K = \frac{\frac{\Pi}{2}\left[\left(\frac{AB}{2}\right)^2 - \left(\frac{MN}{2}\right)^2\right]}{\left(\frac{MN}{2}\right)} \tag{2}$$

and

ρ_a = Apparent Resistivity
K = Geometric factor
V = Volt; I = Current;
R = Resistance
AB = Current Electrodes Separation
MN = Potential Electrodes Separation.

4.0 Discussion and conclusion

The geoelectric section of VES 1 shows six geoelectric layers and its apparent resistivity curve is the AKQQ – type, with $\rho_1 < \rho_2 < \rho_3 > \rho_4 > \rho_5 > \rho_6$. The first layer has a resistivity value of 141.90 Ωm with a thickness of 0.70m indicating the top soil. The second layer has a resistivity value of 281.60 Ωm and a thickness of 2.60m, and it is made up of clayey sand. The third layer with a resistivity value of 469.80 Ωm and a thickness of 6.00m contains sand. The fourth and fifth layers are composed of very dry sand. They have resistivities of 2692.10 Ωm and 2148.10 Ωm and corresponding thicknesses of 14.40 and 28.30 metres respectively. The sixth layer is the aquifer layer. It consists of clayey sand with a resistivity value of 223.30 Ωm.

The geoelectric section of VES 2 indicates seven geoelectric layers and its apparent resistivity curve is the KQHKQ – type, with $\rho_1 < \rho_2 > \rho_3 > \rho_4 < \rho_5 > \rho_6 > \rho_7$. The first layer has a resistivity value of 136.80 Ωm and a thickness of 0.50m is the top soil. The second layer which has a resistivity of 1380.40m and a thickness of 1.70m could be very dry sand. The third layer of resistivity value 658.90 Ωm and a thickness of 2.00m contain lateritic sand, and it is suspected to be a shallow aquifer. The fourth layer with a resistivity of 409.60 Ωm and a thickness of 4.20m is composed of sand. The fifth and sixth layers are made up of very dry sand with resistivities 2797.40 Ωm and 1231.20 Ωm, and a corresponding thickness of 27.00 and 45.10 metres. The seventh layer containing clayey sand and having a resistivity value of 263.60 Ωm is the aquifer.

The geoelectric section of VES 3 expresses seven geoelectric layers and its apparent resistivity curve is the AAAKQ – type, with $\rho_1 < \rho_2 < \rho_3 < \rho_4 < \rho_5 > \rho_6 > \rho_7$. The first layer with a resistivity value of 66.00 Ωm and a thickness of 0.60m is the top soil. The second layer of resistivity value of 315.80 Ωm with a thickness of 0.70m contains very dry sand.

The third layer has a resistivity value of 1171.60 Ωm and a thickness of 2.30m .It is suspected to be lateritic sand. The fourth, fifth and sixth layers of resistivities 1323.50 Ωm , 2002.30 Ωm and 1435.10 Ωm , and thicknesses 13.60, 33.30 and 56.30 metres respectively are composed of very dry sand. The seventh layer which contains sand and has a resistivity value of 909.70 Ωm is the aquifer layer.

Conclusively, the interpretation of the vertical electrical sounding data confirmed the existence of suitable aquifer that could be tapped for borehole project in Crawford University at the various VES locations.

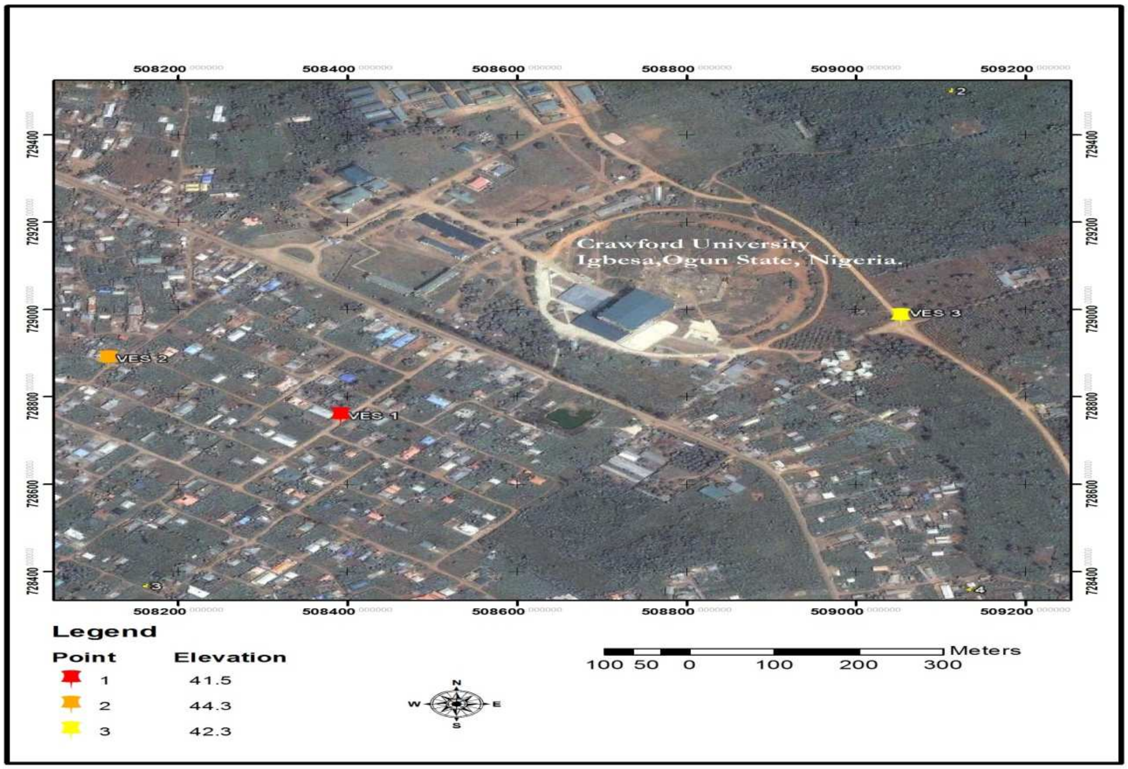

Figure 1: Map of Crawford University, Igbesa, Ogun State, showing the VES locations.

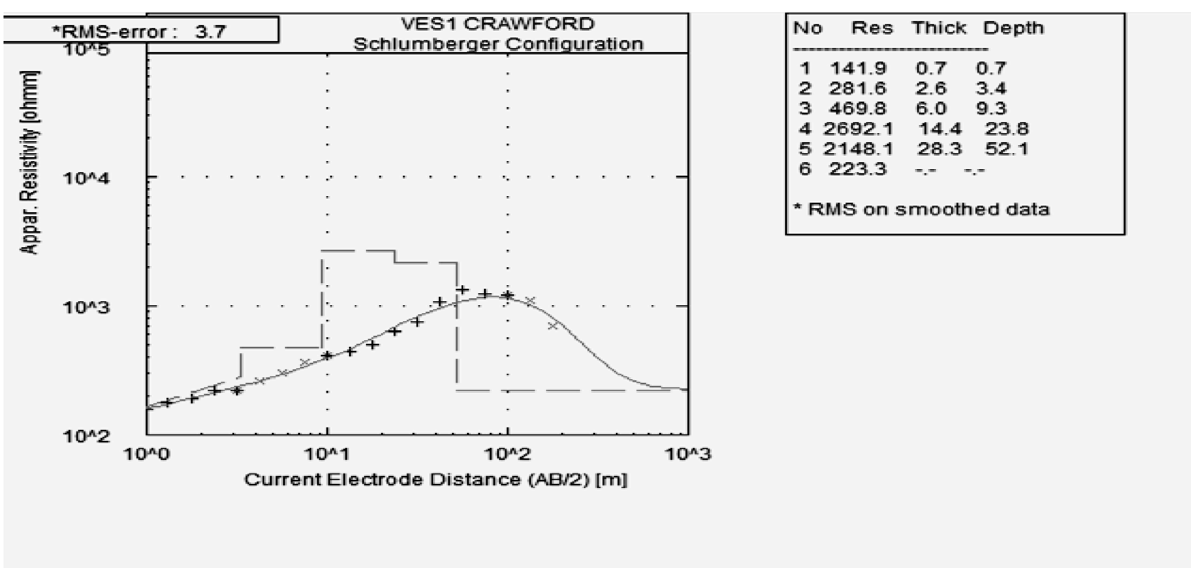

Figure 2: Field and theoretical curves for VES 1

Table 1: Geoelectric layer parameter analysis of VES No. 1

Geoelectric layer	Resistivity (Ωm)	Thickness (m)	Depth (m)	Lithology
1	141.90	0.70	0.70	Top soil
2	281.60	2.60	3.30	Clay sand
3	469.80	6.00S	9.30	Sand
4	2692.10	14.40	23.70	Sand (very dry)
5	2148.10	28.30	52.00	Sand (very dry)
6	223.30	-	-	Clayey sand

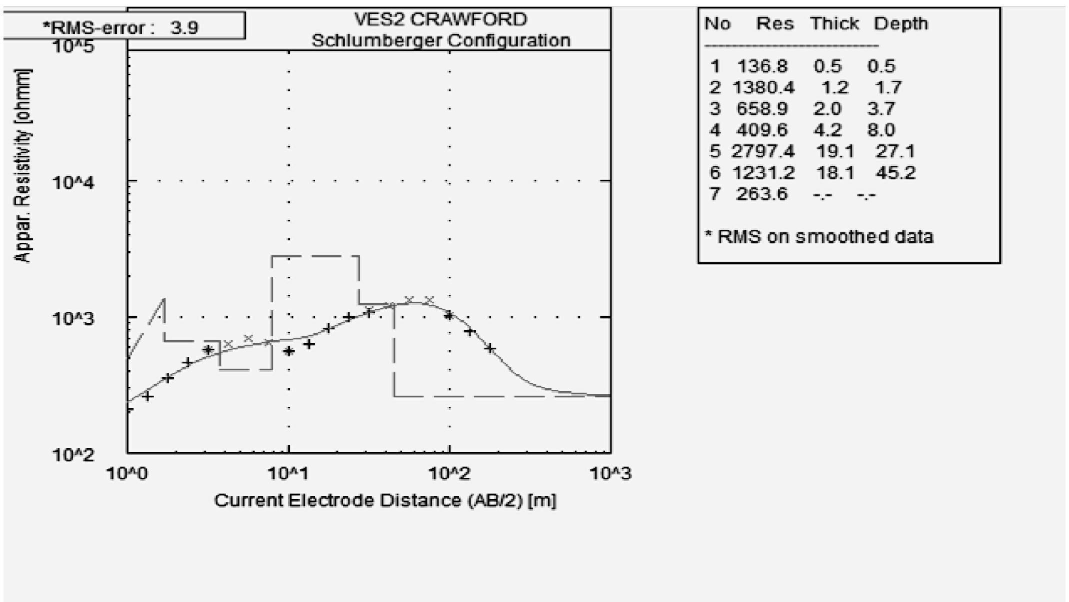

Figure 3: Field and theoretical curves for VES 2

Table 2: Geoelectric layer parameter analysis of VES No. 2

Geoelectric layer	Resistivity (Ωm)	Thickness (m)	Depth (m)	Lithology
1	136.80	0.50	0.50	Top soil
2	1380.40	1.20	1.70	Sand (very dry)
3	658.90	2.00	3.70	Lateritic sand
4	409.60	4.20	7.90	Sand
5	2797.40	19.10	27.00	Sand (very dry)
6	1231.20	18.10	45.10	Sand (very dry)
7	263.60	-	-	Clayey sand

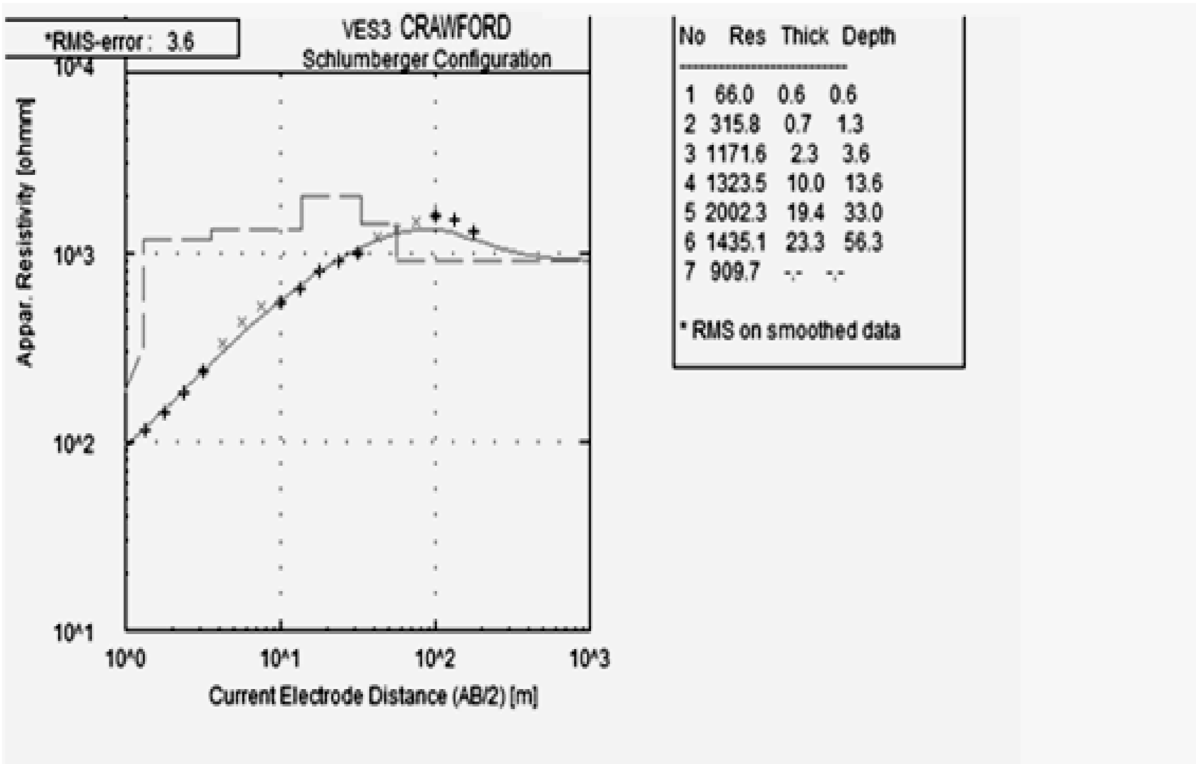

Figure 4: Field and theoretical curves for VES 3

Table 3: Geoelectric layer parameter analysis of VES No. 3

Geoelectric layer	Resistivity (Ωm)	Thickness (m)	Depth (m)	Lithology
1	66.00	0.60	0.60	Top soil
2	315.80	0.70	1.30	Sand (very dry)
3	1171.60	2.30	3.60	Lateritic sand
4	1323.50	10.00	13.60	Sand (very dry)
5	2002.30	19.40	33.00	Sand (very dry)
6	1435.10	23.30	56.30	Sand (very dry)
7	909.70	-	-	Sand

Table 4: Summary of results

Geoelectric Layer	Curve Shape	Depth to Aquifer(m)	Latitude	Longitude	Elevation (m)
1.	AKQQ	Below 52.00	E003^0 04$^/$ 33.3$^{//}$	N06^0 35$^/$ 34.7$^{//}$	41.50
2.	KQHKQ	Below 45.10	E003^0 04$^/$ 24.4$^{//}$	N06^0 35$^/$ 39$^{//}$	44.30
3.	AAAKQ	Below 56.30	E003^0 04$^/$ 54.9$^{//}$	N06^0 35$^/$ 42.4$^{//}$	42.30

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