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Aquifer Characterization In Ugha And Ehor Environs, Edo State, Nigeria Using Vertical Electrical Soundings

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Abstract

The purpose of location of the depth of groundwater (aquifer) in the area under study is to make easy for boreholes drilling. This is to enable the inhabitants to be accessible to quality water supply in order to enhance rural development.

Vertical Electrical Soundings using the Schlumberger electrode configuration with a maximum of current electrodes spacing of 1362 m was carried in four locations in Ugha and Ehor. The ABEM SAS 300C Terrameter with a Booster 2000 was used for deeper current penetration. The GPS 76csx was also used to locate the northing and easting of sites and elevation of each VES point.

The VES data were interpreted both manually and computer iterations using the Interpex 1Dv2 software. The results of the analysis of data indicate that there exist thick aquifers in the area of survey; Ugha 1, 83.1 m, Ugha 2, 63.8 m, Ugha 3, 181.1 m and Ehor, 74.2 m. The corresponding aquifer depths are Ugha 1, 195.7 m, Ugha 2, 124.4 m, Ugha 3, 198.6 m and Ehor, 179.6 m. This results correlate with the borehole logs at Watch Tower, Igieduma and Ehor.

1.0 Introduction

Over the years Electrical Geophysical Prospecting Method has been used for groundwater exploration. Using electrical resistivity method, one may measure potential, current and electromagnetic fields that occur naturally or are introduced artificially into the ground. It is the enormous variation in electrical resistivity found in different rocks and materials that makes these techniques possible [5]. The advantage of the geoelectric method over others in the groundwater exploration is further buttress by the work of [3].

However, groundwater development has been a perennial problem in the area under survey. The area has suffered borehole failures as a result of inadequate estimation depth to aquifer data. Table 1, shows the analysis of the working and non-working boreholes and availability of boreholes logs in the area. The non-availability of logs indicates that the wells were dung without recourse to survey. This must have been an associated perennial problem to the development of groundwater and borehole failures in the area. This study therefore, tries to proffer solution to the problem of depth to aquifer in the area using Vertical Electrical Sounding (VES) method.

Table 1: Analysis of working and non-working boreholes in Ugha and Ehor Environs.

S/No.	Community	Agent	Status	Available borehole log.
1	Ugha 1	NGO	Working	No
2	Ugha 2	Private	Not working	No
3	Ugha 3	Private	Not working	No
4	Ugha 4	Private	Working	No
5	Obagie	Public	Not working	No
6	Erua	Missionary	Working	No
7	Iriwe	Private	Working	No
8	Igieduma	Missionary	Working	Yes
9	Ehor 1	Public	Not working	Yes
10	Ehor 2	Public	Not working	No

Theory

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Electrical current flow in any medium is determined by Ohm's law. In a homogeneous and isotropic earth media, the electric field E is: $J = \sigma E$ (1.1)

where $E = -\nabla V$ (1.2)

J is current density. V satisfies Laplace's equation $\nabla^2 V = 0$. (1.3)

Since V depends on distance r, Laplace's equation in spherical coordinates,

r-dependence only;

$$\nabla^2 V = 0 = \frac{1}{r^2}\left[\frac{\partial}{\partial r}\left(r^2 \frac{\partial V}{\partial r}\right)\right] \quad (1.4)$$

with solution $V = -\frac{A}{r} + B$ (1.5)

Since potential V=0 as r→∞, B=0

Therefore $V = -\frac{A}{r}$ (1.6)

But from equation (1.2), $E = -\nabla V$, then $\nabla V = \frac{A}{r^2}$ (1.7)

and $E = -\frac{A}{r^2}$ (1.8)

For current passing a spherical surface; $\int J.ds = I$ (1.9)

$$I = \sigma E 4\pi r^2 \quad (2.0)$$

Recall from equations (1.1) and (1.8); $I = \sigma A 4\pi \frac{r^2}{r^2}$ (2.1)

$$I = \sigma A 4\pi \quad (2.2)$$

$$A = -\frac{I}{4\pi\sigma} = -\frac{I\rho}{4\pi} \quad (2.3)$$

Using equations (1.6) and (2.3); $V = \frac{I\rho}{4\pi r}$. (2.4)

In a half space hemisphere, $V = \frac{I\rho}{2\pi r}$ (2.5)

Result and Discussion

The results of the geoelectric sections show the subsurface view of the study area. This indicates the presence of seven to eight geoelectric layers with thick aquifer (Table 2 and Figures 1-4). The results of the VES investigation reveals consistent thickness of aquifer of (63.1 m - 181.1 m), which is an indication of good water source.The lithology composed of topsoil, sand, sandstones and clayey sand. The delineation of the lithology of the study area comfirms the existence of the Benin formation[4]. The study also identify the depth to aquifer. Ugha 3 from all indications, the thickness of the geoelectric layers with slight increase from one layer to another before the aquiferous zone shows the presence of hard pan.

Table 2: Summary of the interpreted four sample VES curves

Geoelectric Layer	UGHA 1		UGHA 2		UGHA 3		EHOR	
	Thickness (m)	Depth (m)	Thickness (m)	Depth (m)	Thickness (m)	Depth (m)	Thickness (m)	Depth (m)
1	0.7	0.7	0.5	0.5	0.3	0.3	1.5	1.5
2	2.6	3.4	0.5	1.0	0.5	0.8	0.5	2.0
3	24.3	27.7	13.9	14.9	1.4	2.2	8.5	10.5
4	60.2	87.9	15.2	30.1	3.1	5.3	39.6	50.0
5	24.7	112.6	30.4	60.6	2.2	7.5	55.6	105.6
6	83.1	195.7	63.8	124.4	10.0	17.5	74.2	179.6
7	∞		∞		181.1	198.6	∞	
8					∞			

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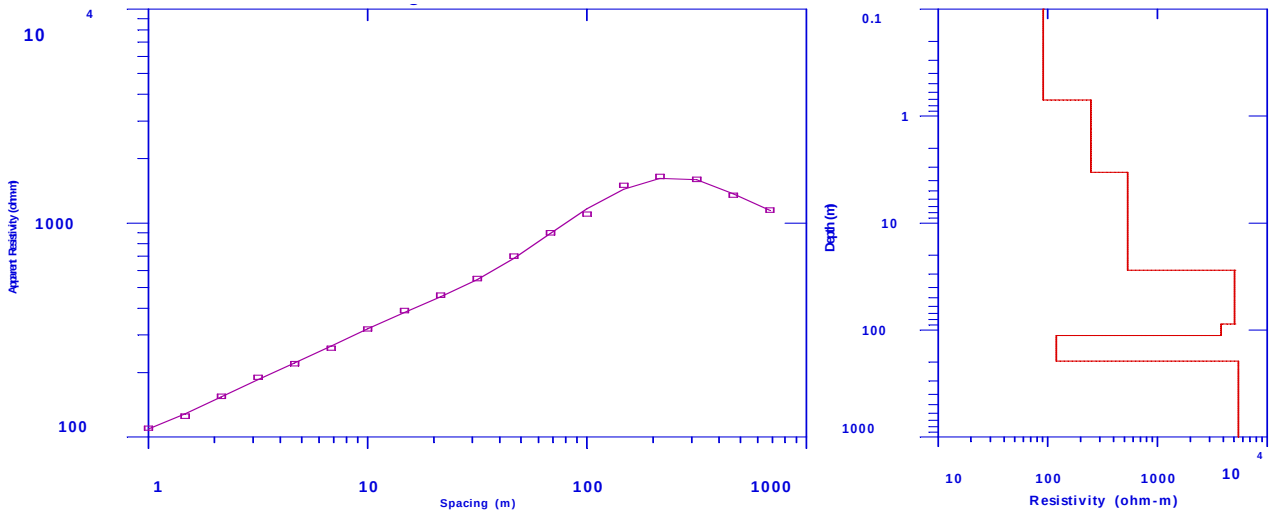

Figure 1, Ugha 1: Schlumberger Sounding and Model Curve

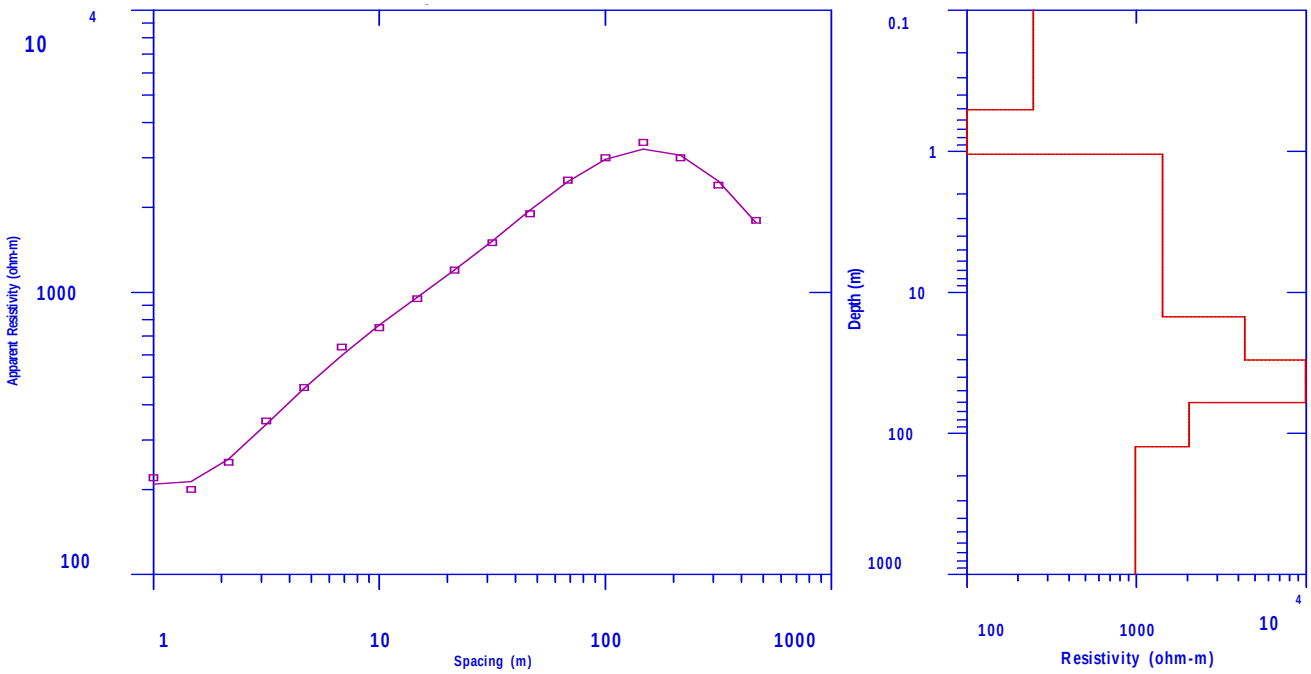

Figure 2, Ugha 2: Schlumberger Sounding and Model Curve

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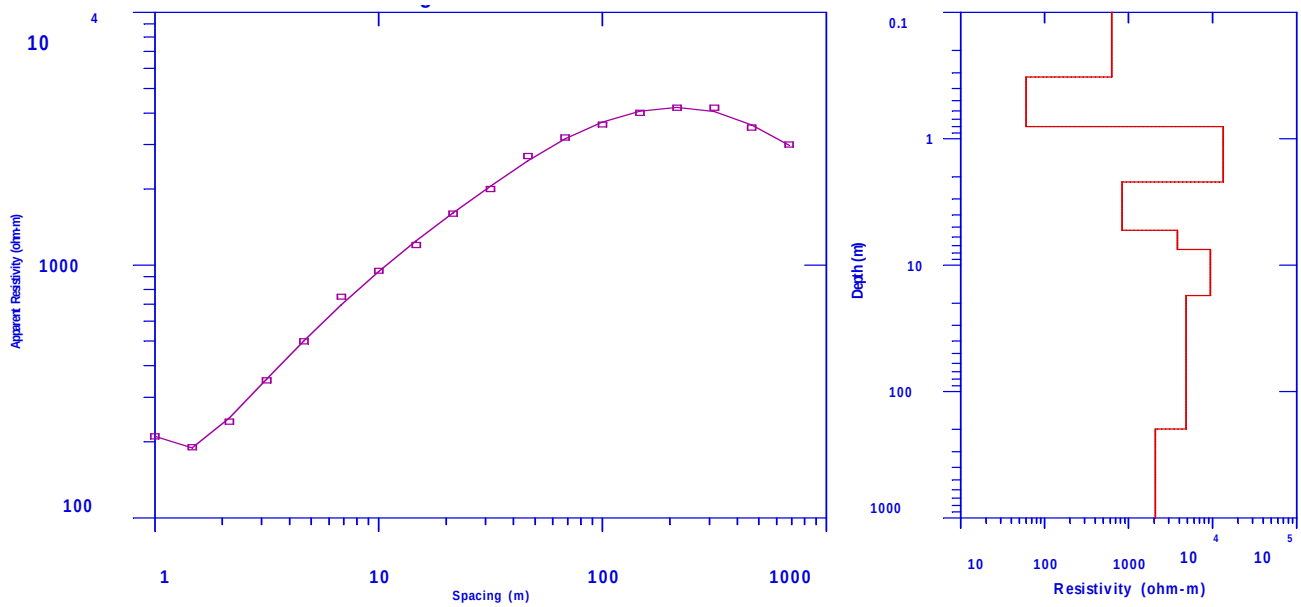

Figure 3, Ugha 3: Schlumberger Sounding and Model Curves

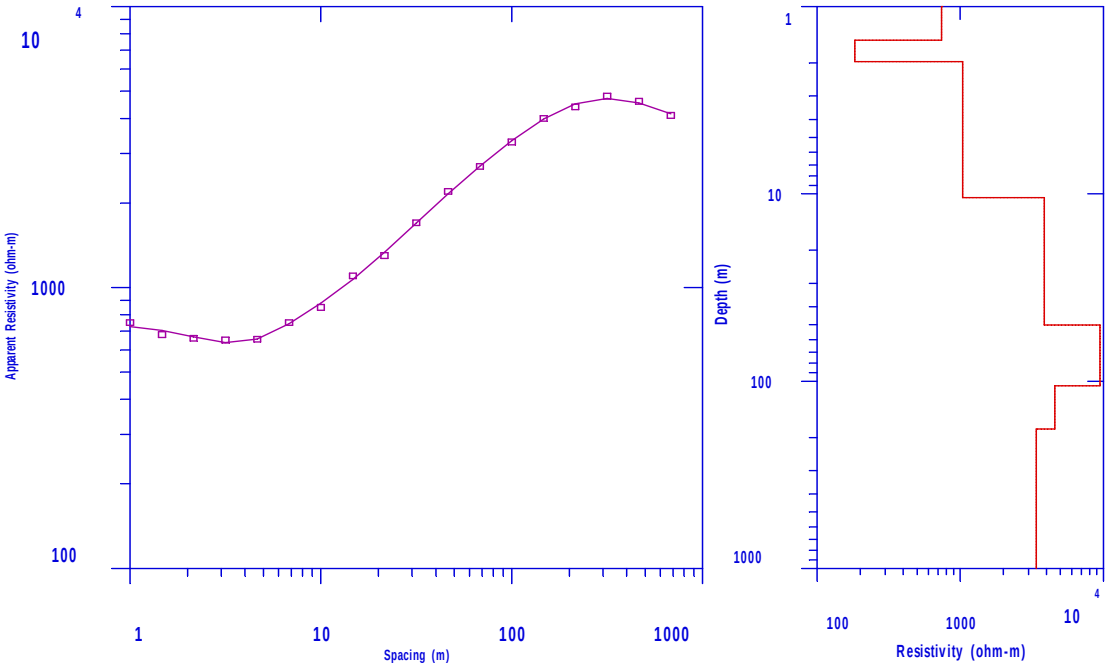

Figure 4, Ehor: Schlumberger Sounding and Model Curve

Conclusion

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The depth to aquifer at Ugha 1 is 195.7 m; Ugha 2, 124.4 m; Ugha 3, 198.6 m and Ehor 179.6 m. These results were in agreement with the borehole logs at Watch Tower, Igieduma [2]. Table 1, shows the analysis of the borehole logs in the area with over sixty percent of them being without log profiles. This can result into borehole failure and subsequently underdeveloped groundwater utilization in the area of research.

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