Geo-electrical Resistivity Evaluation of Groundwater Potential at University Of Benin Ugbowo Campus, Benin-City, Edo State of Nigeria, Using the Schlumberger Array

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ABSTRACT: Geo-electrical resistivity survey was conducted in part of the University of Benin, Benin-City, Ovia Northeast of Edo State, Nigeria, with a view to establishing the most dependable aquifer bearing zone and the lateral and vertical variation of subsurface lithology with distance and depth respectively. In this study, the schlumberger electrode configuration was employed for the acquisition of VES data in the field. A total of 6 VES stations were engaged within the study area. A, H and HK resistivity curve types were identified, reflecting facies or lithological variations in the area. Three patterns of geo-electrical resistivity curves obtained using IP2WIN software can be associated with different rock formations in the study area. Dar Zarruk Parameters were tools used for aquifer characterization in determining the groundwater potential of the area and capacity bearing rating, viz: Total transverse resistance (T) and Total longitudinal conductance (S), Resistivity Contrast (RC) and Resistivity Reflection Coefficient (RRC). Results obtained shows that VES 1 (coordinate N6° 23'56.69'', E5° 37' 32.83'') with four layers and an A curve type is the most potential source for groundwater compared to other VES points. It is a sandy clay layer of resistivity 198Ωm, with thickness to infinity and well confined at the top by a laterite layer. VES 1 has the highest Total Traverse Resistance 690310 Ωm^2 (showing a very good transmmitivity of the layer), Resistivity Contrast (0.01) and Resistivity Reflection Coefficient (0.90), all parameters falling within good prospect for groundwater development, but has a Total Longitudinal Conductance (S) value of 0.002 mho which shows that VES 1 has a poor bearing capacity. In summary, the results of the geo-electrical resistivity survey conducted at the Vice Chancellor's Lodge area of University of Benin using Schlumberger Array, revealed the most dependable aquifer bearing zone and the lateral and vertical variation of subsurface lithology with distance and depth respectively.

Water is so important for life sustenance; hence the need for effectual prospecting and successive determination of potential areas of groundwater accumulation is a serious matter to be dealt with. Resistivity techniques especially the Vertical Electrical Sounding (VES) method has been used for investigating subsurface layer properties and groundwater potential.

This method was found suitable for hydro-geological surveys in sedimentary rocks (Hadi, 2009). By this method, the subsurface characterization is determined based on the change of resistivity values with depth.

A VES is typically carried out in Schlumberger array, where the potential electrodes are placed in fixed positions with a short separation and the current electrodes are placed symmetrically on the outer sides of the potential electrodes.

However, the electrical formation resistivity is defined by the clay content of the formation with clayish less permeable formations revealing low resistivity and sandy permeable formations showing high resistivity. According to Chistensen and Sorensen (1998) and Sorensen *et al.* (2005), the geo-electrical method is capable of mapping both low and high resistive formations and therefore a valuable tool for vulnerability studies. Resistivity values can provide an overview of the groundwater type that exists in the study area. The Climate and geology of an area has a lot to tell about the geochemistry of its groundwater. Schlumberger array method was employed in this study with the view of determining the geo-electrical characteristic of the sub-surface layers and identifying suitable area with the most viable aquifers.

MATERIALS AND METHOD

Location of Study Site and Hydrogeological Setting: This study was carried out in University of Benin, Ugbowo Campus, Benin City, the capital of Edo State,

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Nigeria and is located in the south-south geopolitical zone of Nigeria; bounded by latitudes 6° 06' N, 6° 30' N and longitudes 5° 30' E, 5° 45' E and area of about 500 square kilometers.
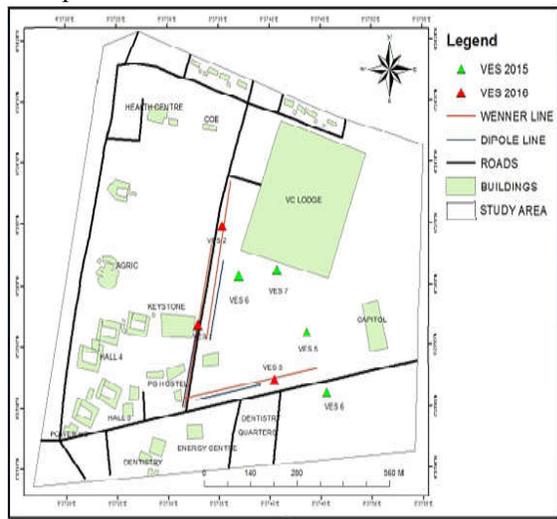

Fig. 1: Map of the study area

Although transportation and petty trading is the major business in the city, other activities engaged include two brewing factories, a petroleum storage depot and oil pipeline, furniture factories, four small-scale pharmaceutical production factories, metal works, and colour photo laboratories. Benin City falls within the tropical equatorial zone dominated by dry season (November – March) and wet seasons (April – October). Short and Stauble (1967) had described the City as being underlain by sedimentary formation.

The formation is made up of top reddish clayey sand capping highly porous fresh water bearing loose pebby sands, and sandstone with local thin clays and shale interbeds which are considered to be of braided stream origin. Erah *et al.,* (2002) had reported that the sands, sandstones and clays vary in colour from reddish brown to pinkish yellow on weathered surfaces to white in the deeper fresh surfaces, and that limonitic coatings are responsible for the brown reddish-yellowish colour.

They also reported that the formation is covered with loose brownish sand (quaternary drift) varying in thickness and is about 800 m thick; almost all of which is water bearing with water level varying from about 20 m to 52 m.

It is generally believed to be highly permeable, porous and prolific in water yield. Short and Stauble (1967) reported that the aquifer yields range from 28.4 m3 hr-1 at Iyanomo (south of the City), 125 m3 hr-1 at Uselu (central part) to 208 m3 hr-1 at Ogba (northern part) with a draw down ranging from 4.8 m at Iyanomo, 1.8 m at Uselu to 6.7 m at Ogba.
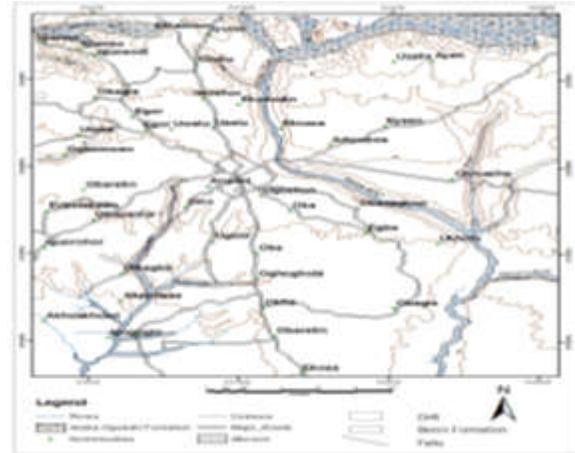

Fig. 2: Benin region geological formation (source: Akujieze, 2004)

Method: In this research work, the schlumberger array in electrical resistivity survey was adopted. The basic field equipment for this study is the ABEM terrameter which displays apparent resistivity values digitally as computed from ohms law. It is powered by a 12.5v D.C power source. Other accessories attached to the terrameter includes the booster, four metal electrodes, cables for current and potential electrodes, hammers, measuring tapes, walking talking or phones for very long spread.
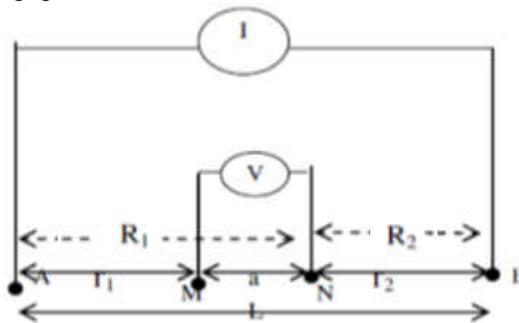
Fig 3: Schlumberger Field Electrode Configuration.

Where "a" is the distance between the potential electrodes, L is the distance between current electrodes. Okwueze and Ezeanyim (1985), Zohdy (1988).

In this configuration, the four electrodes are positioned symmetrically along a straight line, the current electrodes on the outside and the potential electrodes on the inside. To change the depth range of the measurements, the current electrodes are displaced outwards while the potential electrodes in general are left at the same position. The resistance readings were used for computing the apparent resistivity using Schlumberger electrode configuration based on the following relationship:

Where, ρ is the apparent resistivity, V is the potential difference (volt, V) and *I* is the electric current (ampere, A).

$$V = U_M - U_N = \frac{\rho l}{2\pi}\left[\frac{1}{AM} - \frac{1}{BM} + \frac{1}{BN} - \frac{1}{AN}\right]$$

Where, U_M and U_N = potentials at *M* and *N,*; *AM* = distance between electrodes *A* and *M*, etc.

These distances are always the actual distances between the respective electrodes, whether or not they lie on a line. The quantity inside the brackets is a function only of the various electrode spacing. The quantity is denoted 1/*K*, which allows rewriting the equation as:

$$V = \frac{\rho l}{2\pi}\left[\frac{1}{K}\right],$$

Where *K* = array geometric factor that depends on the arrangement of the four electrodes A, B, M and N. To obtain the resistivity, ρ:

$$\rho = 2\pi K \frac{V}{l},$$

The resistivity of the medium can be found from measured values of *V*, *I*, and *K*.

The above relationships holds provided that the current electrode spread AB/2 is equal to or greater than five times the potential electrode spread MN/2 with the depth of investigation as a function of electrode spacing. Based on the prevailing geologic condition during the survey, a maximum outer electrode spacing of 215m was made at the sounding station. When the ratio of the distance between the current electrodes to that between the potential electrodes becomes too large, the potential electrodes must also be displaced outwards otherwise the potential difference becomes too small to be measured with sufficient accuracy (koefoed, 1979). Measurements of current and potential electrode positions are marked such that

$$AB/2 \geq MN/2,$$

Where; AB/2 = current electrode spacing; MN/2 = potential electrode spacing.

The Vertical Electrical Sounding data are plotted and inverted using IPI2win software which creates a 1-D model from the sounding data. The geological interpretation was done using the representative values of resistivity while Strater 3 software was used to draw the 1D subsurface model for visualization. Dar Zarrouk parameters, longitudinal conductance and Transverse resistance of each geo-electric layer were computed. The transmissivity of an aquifer is directly proportional to its transverse resistance (Ward, 1990). The longitudinal conductance is directly proportional to the conductivity of geologic material. The electrical reflection coefficient of each geo-electric boundary; longitudinal conductance and transverse resistance were computed using the formulas:

$$RRC = \left[\left(\rho_n - \rho_{n-1}/\rho_n + \rho_{n-1}\right)\right]$$

$$RC = \left[\left(\rho_n/\rho_{n-1}\right)\right]$$

$$T = \Sigma\, h_i\rho_i = h_1\rho_1 + h_2\rho_2 + \cdots h_n\rho_n\,(ohm - m^2)$$

$$S = \Sigma\, h_i/\rho_i = h_1/\rho_1 + h_2/\rho_2 \ldots h_n/\rho_n\,(mho)$$

Where: RRC = Resistivity reflection coefficient; RC = Resistivity contrast; T = Total transverse resistance
S = Total longitudinal conductance; ρ_n = Resistivity of the nth layer; ρ_{n-1} = Resistivity of the (n-1) th layer
h_n = Thickness of the nth layer

RESULT AND DISCUSSION

The Vertical Electrical Sounding data obtained for the geophysical survey carried out at part of the University of Benin are presented in Table 1. *Interpretation for VES 1 Data:* The results of the interpreted resistivity data for VES 1 present two layer curve (A). The computer interpretation of the observed curve resolved the penetrated rocks at the site into (4) geo-electric layers. The first layer resistivity value is 257Ωm with a depth of 0.5m is interpreted as laterite; the second layer resistivity value is 672Ωm with a depth of 10.8m is laterite. The third layer resistivity value is 18913Ωm with depth 36.1m is interpreted also as laterite, while the fourth layer resistivity value is 198.0Ωm with a depth to infinity. Finally, the water table is suspected to lie in the fourth layer.

Interpretation for VES 2 Data: The results of the interpreted resistivity data for VES 2 presented an (HK) shape type curve. The computer interpretation of the observed curve resolved the penetrated rocks at the site into (5) geo-electric layers. The first layer resistivity value is 570Ωm with a depth of 1.56m is interpreted as Topsoil; the second layer resistivity value is 220Ωm with a depth of 3.86m is laterite.

The third layer resistivity value is 2098Ωm with depth 29.8.1m is interpreted as laterite, the fourth layer resistivity value is 613.0Ωm with a depth of 83.3m is interpreted as Dry Sand. The fifth layer resistivity value is 22816Ωm with depth to infinity.

Table 1: Vertical Electrical Sounding 1 data

Location	VC Lodge	VES 1	Latitude	N6° 23′ 56.69″		
			Longitude	E5°37′32.83′′	Observed	Computed
S/N	AB/2 (m)	MN/2 (m)	R(Ω)	K	ϱ_a (Ωm)	ϱ_a (Ωm)
1	1.0	0.2	45.8	7.54	345.33	345.3
2	1.47	0.2	24.7	16.66	411.5	411.5
3	2.15	0.2	13.67	35.99	491.98	492
4	3.16	0.2	7.38	73.12	539.63	539.6
5	4.64	0.2	3.62	168.80	611.06	611.1
6	6.81	0.2	2.15	363.17	780.82	653.82
7	10.0	2.0	8.04	75.41	606.3	721.73
8	14.7	2.0	4.63	166.60	771.36	879.45
9	21.5	2.0	2.59	359.96	932.3	1126
10	31.6	2.0	2.03	781.22	1585.88	1586
11	46.4	2.0	1.36	1688.01	2295.69	2249
12	68.1	2.0	0.965	3639.70	3512.31	2936
13	100	20	5.71	754	4305.34	3474
14	147	20	2.32	1665.97	3865.05	3865
15	215	20	0.78	3599.55	2807.65	3722

Table 2: showing sub-surface characteristics of VES 1 points

Layer	VES 1: Resistivity(Ωm)	Depth to Top(m)	Thickness (m)	Inferred Lithology	Remarks
1	257	8.5	0.5	Lateritic (weathered)	
2	672	11.3	10.8	Laterite (weathered)	
3	18913	47.4	36.1	Laterite	
4	198	-	-	Sandy clay	Potential
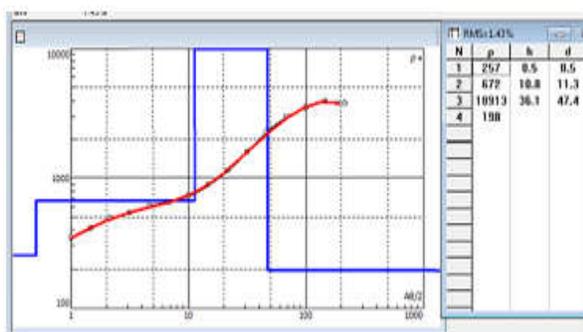
Fig. 4: Vertical Electrical Sounding data 1 Curve and model
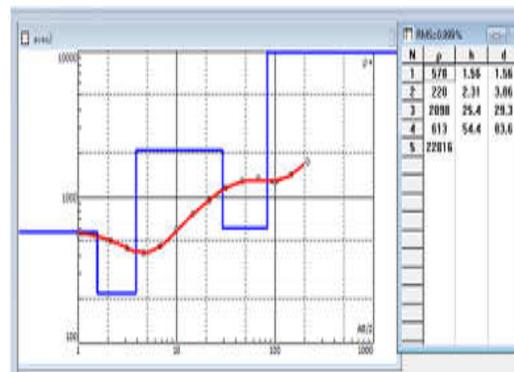
Fig. 6: VES 2 Model and Curve
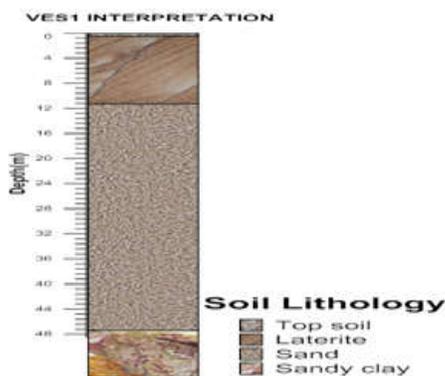
Fig. 5: Lithology of VES 1 interpretation
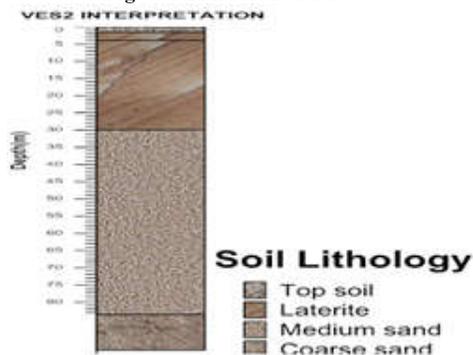
Fig. 7: Lithology of VES 2 interpretation
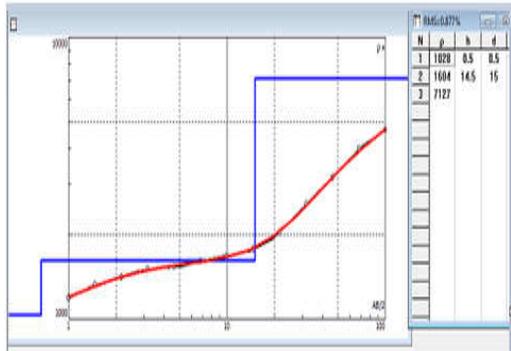
Fig. 8: Vertical Electrical Sounding 3 model and curve


Fig. 9: Lithology of Vertical Electrical Sounding 3 interpretation

Interpretation for VES 2 Data: The results of the interpreted resistivity data for VES 2 presented an (HK) shape type curve. The computer interpretation of the observed curve resolved the penetrated rocks at the site into (5) geo-electric layers. The first layer resistivity value is 570Ωm with a depth of 1.56m is interpreted as Topsoil; the second layer resistivity value is 220Ωm with a depth of 3.86m is laterite. The third layer resistivity value is 2098Ωm with depth 29.8.1m is interpreted as laterite, the fourth layer resistivity value is 613.0Ωm with a depth of 83.3m is interpreted as Dry Sand. The fifth layer resistivity value is 22816Ωm with depth to infinity.

Interpretation For VES 3 Data: The results of the interpreted resistivity data for VES 3 presented an (A) shape type curve. The computer interpretation of the observed curve resolved the penetrated rocks at the site into (3) geo-electric layers. The first layer resistivity value is 1028Ωm with a depth of 0.5m is interpreted as Topsoil; the second layer resistivity value is 1604Ωm with a depth of 15m is laterite. The third layer resistivity value is 7127Ωm with depth to infinity is interpreted as laterite, This VES point shows no striking potential for underground water potential

Table 3: Vertical Electrical Sounding 2 data

Location S/N	VC Lodge Area AB/2(m)	VES 2 MN/2 (m)	Latitude Longitude R(Ω)	N6^O 24' 4.87" E5^{0}37'35.21'' K	Observed ϱ_a (Ωm)	Computed ϱ_a (Ωm)
1	1.0	0.2	64.8	7.54	488.59	467.23
2	1.47	0.2	32.4	16.66	539.78	458
3	2.15	0.2	12.82	35.99	461.39	419
4	3.16	0.2	6.22	73.12	454.81	372
5	4.64	0.2	2.12	168.80	357.86	343
6	6.81	0.2	1.225	363.17	444.88	383
7	10.0	2.0	8.75	75.41	659.84	495.7
8	14.7	2.0	3.82	166.60	636.41	636
9	21.5	2.0	2.15	359.96	773.91	788
10	31.6	2.0	1.35	781.22	1054.65	961.2
11	46.4	2.0	0.81	1688.01	1367.29	1061
12	68.1	2.0	0.420	3639.70	1528.67	1115
13	100	20	1.27	754	957.58	1051
14	147	20	0.77	1665.97	1282.8	1195
15	215	20	0.546	3599.55	1965.35	1456
16	215	20	0.485	3599.55	1745.78	1746

Table 4: showing sub-surface characteristics of VES 2 points

| Layer	Resistivity (Ωm)	Depth to Top(m)	Thickness (m)	Infer Lithology	Remarks
1	578	1.56	1.56	Top soil	
2	220	3.86	2.31	Laterite	Weathered
3	2098	29.3	25.4	Laterite	Lower part of the laterite probably have resistivity equivalent to the fine sand just overlain it, for such a high geo-electric layer thickness.
4	613	83.6	54.4	Sand	Dry Sand
5	22816	-	-	Laterite	

Table 5: Vertical Electrical Sounding 3 data

Location	VC Lodge Area	VES 3	Latitude Longitude		Observed	Computed
S/N	AB/2(m)	MN/2 (m)	R (Ω)	K	ϱ_a (Ωm)	ϱ_a (Ωm)
1	1.0	0.2	157	7.54	1183.78	1184
2	1.47	0.2	79.1	16.66	1317.81	1318
3	2.15	0.2	39.1	35.99	1407.21	1407
4	3.16	0.2	20.6	73.12	1506.27	1506
5	4.64	0.2	9.46	168.80	1596.85	1525
6	6.81	0.2	4.50	363.17	1634.27	1597
7	10.0	0.2	2.13	785.19	1672.45	1672
8	14.7	2.0	10.20	166.60	1699.32	1764
9	21.5	2.0	4.37	359.96	1573.03	2026
10	31.6	2.0	4.54	781.22	3546.74	2552
11	46.4	2.0	1.59	1688.01	2683.94	3152
12	68.1	2.0	1.18	3639.70	4294.85	3997
13	100	2.0	0.58	7851	4553.58	4678

Table 6: showing sub-surface characteristics of Vertical Electrical Sounding 3 point

Layer	VES3 Resistivity (Ωm)	Depth to Top(m)	Thickness (m)	Infer Lithology	Remarks
1	1028	0.5	0.5	Topsoil	Sandy
2	1604	15	14.5	Laterite	
3	7127	-	-	Laterite	

.

Table 7: Vertical Electrical Sounding 4 data

Location	VC Lodge (Capitol)	VES 4	Latitude	N6^O 23ˊ 51.2ʺ		
			Longitude	E5^{0}37'.45.3''	Observed	Computed
S/N	AB/2(m)	MN/2 (m)	R(Ω)	K	ϱ_a (Ωm)	ϱ_a (Ωm)
1	1.0	0.2	146.5	7.54	1104.61	1195
2	1.47	0.2	82.9	16.66	1381.11	1381
3	2.15	0.2	44.7	35.99	1608.75	1609
4	3.16	0.2	25.1	73.12	1835.31	1655
5	4.64	0.2	12.52	168.80	2113.38	1827
6	6.81	0.2	5.76	363.17	2091.86	1864
7	10.0	0.2	2.02	785.19	1586.08	1864
8	14.7	0.2	1.06	1697	1798.82	2017
9	21.5	1.0	2.77	726	2011.02	2162
10	31.6	1.0	1.60	1569	2510.4	2510
11	46.4	1.0	1.04	3382	3517.28	3241
12	68.1	2.0	1.26	3639	4585.14	4585
13	100	2.0	0.30	7851	2355.3	6410
14	147	2.0	2.65	16969	44967.85	9708
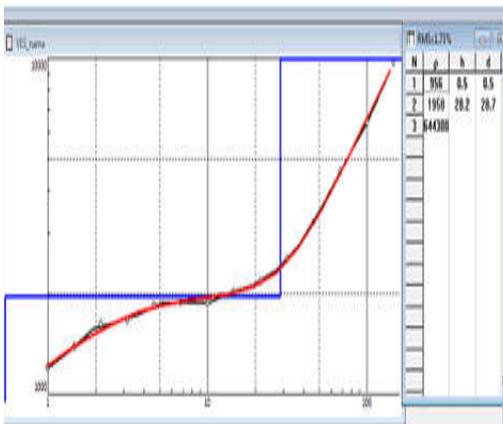
Fig. 10: Vertical Electrical Sounding 4 curve and mode

Fig 11: Lithology of Vertical Electrical Sounding 4 interpretation

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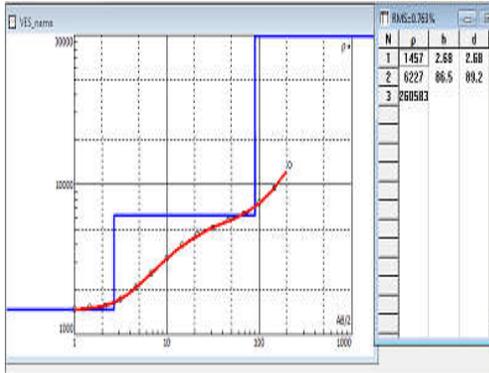
Fig. 12: VES 5 model and curve
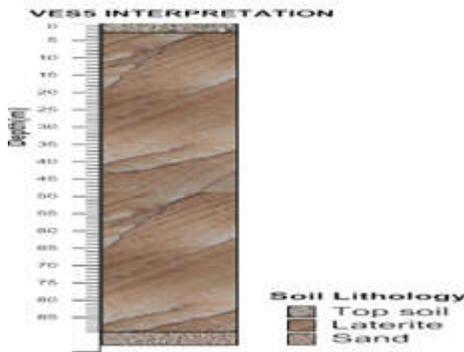
Fig. 13: Lithology of VES 5 interpretation

Interpretation for VES 4 Data: The results of the interpreted resistivity data for VES 4 presented an (A) shape type curve. The computer interpretation of the observed curve resolved the penetrated rocks at the site into (3) geo-electric layers. The first layer resistivity value is 956Ωm with a depth of 0.5m is interpreted as Topsoil; the second layer resistivity value is 1950Ωm with a depth of 28.7m is laterite. The third layer resistivity value is 644380Ωm with depth to infinity is interpreted as laterite, This VES point shows no striking potential for underground water.

Interpretation for VES 5 Data: The results of the interpreted resistivity data for VES 5 presented a (K) shape type curve. The computer interpretation of the observed curve resolved the penetrated rocks at the site into (3) geo-electric layers. The first layer resistivity value is 1457Ωm with a depth of 2.68m is interpreted as Laterite; the second layer resistivity value is 6227Ωm with a depth of 86.5m is laterite. The third layer resistivity value is 260585Ωm with depth to infinity is interpreted as laterite, This VES point shows no striking potential for underground water.

**Table 8**: showing sub-surface characteristics of Vertical Electrical Sounding 4 point

Layer	Resistivity (Ωm)	Depth to Top(m)	Thickness (m)	Infer Lithology	Remarks
1	956	0.5	0.5	Top soil	Dry sand
2	1950	28.7	28.2	Laterite	The sediment just underlain it may have equivalent resistivity with it ,for such high geo-electric layer thickness
3	644380	-	-	Laterite	

Table 9: Vertical Electrical Sounding 5 data

Location	VC Lodge	VES5	Latitude Longitude	N6^O 23' 52.9'' E5^{0}37'44.5''	Observed	Computed
S/N	AB/2(m)	MN/2 (m)	R(Ω)	K	ϱ_a (Ωm)	ϱ_a (Ωm)
1	1.0	0.2	159.7	7.54	1204.14	1470
2	1.47	0.2	77.3	16.66	1287.82	1514
3	2.15	0.2	55.5	35.99	1997.45	1545
4	3.16	0.2	29.1	73.12	2127.79	1705
5	4.64	0.2	12.93	168.80	2182.58	2057
6	6.81	0.2	7.06	363.17	2563.98	2564
7	10.0	0.2	2.94	785.19	2308.46	3210
8	14.7	0.2	1.61	1697	2732.17	3911
9	21.5	0.2	2.24	3631	8133.44	4626
10	31.6	1.0	2.54	1569	3985.26	5107
11	46.4	1.0	2.34	3382	7913.88	5750
12	68.1	1.0	1.16	7285	8450.6	6285
13	100	2.0	0.47	7851	3689.97	7508
14	147	2.0	0.46	16969	7805.74	9424
15	215	2.0	0.87	36303	31583.61	13319

Table 10: showing sub-surface characteristics of VES 5 point

Layer	VES 5 Resistivity (Ωm)	Depth to Top(m)	Thickness (m)	Infer Lithology	Remarks
1	1457	2.68	2.68	Laterite	Dry sand
2	6227	89.2	86.5	Laterite	The sediment just underlain it may equivalent resistivity with it ,for such a high geo-electric layer thickness
3	260583	-	-	Laterite	

Table 11: VES 6 data

Location	Beside Keptonic Hostel	VES 6	Latitude	N6^O 24' 00.8"		
			Longitude	E5^{0}37'36.9''	Observed	Computed
S/N	AB/2(m)	MN/2 (m)	R(Ω)	K	ϱ_a (Ωm)	ϱ_a (Ωm)
1	1.0	0.2	63.3	7.54	477.28	477.3
2	1.47	0.2	32.5	16.66	541.45	509.42
3	2.15	0.2	15.42	35.99	554.97	555
4	3.16	0.2	8.01	73.12	585.69	613.6
5	4.64	0.2	4.50	168.80	759.6	759.6
6	6.81	0.2	2.56	363.17	929.72	869.76
7	10.0	0.2	1.20	785.19	942.23	942.2
8	14.7	1.0	3.95	338	1335.1	1335
9	21.5	1.0	1.84	726	1335.84	1645
10	31.6	1.0	0.83	1569	1302.27	2353
11	46.4	1.0	0.78	3382	2637.96	3695
12	68.1	2.0	0.63	3639	2292.57	5275
13	100	2.0	0.60	7851	4710.6	7558
14	147	2.0	7.28	16969	123534.3	11503
15	215	2.0	0.40	36303	14521.2	16298

Interpretation for VES 6 Data: The results of the interpreted resistivity data for VES 6 presented a (A) shape type curve. The computer interpretation of the observed curve resolved the penetrated rocks at the site into (3) geo-electric layers. The first layer resistivity value is 465Ωm with a depth of 1.36m is interpreted as Laterite; the second layer resistivity value is 995Ωm with a depth of 11.3m is Sand (Dry Sand). The third layer resistivity value is 410502Ωm with depth to infinity is interpreted as laterite, This VES point shows no striking potential for underground water.

**Fig. 14**: VES 6 model and curve
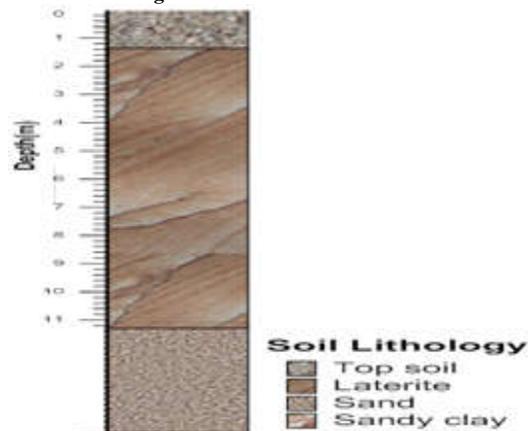
Fig. 15: Lithology of VES 6 interpretation
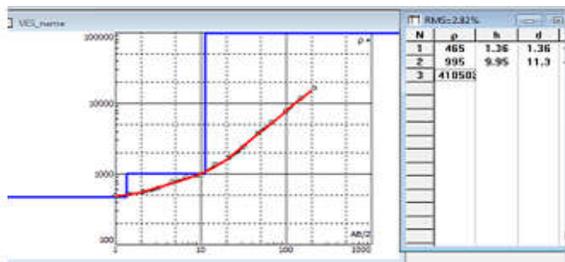
Table 12: showing sub-surface characteristics of VES 6 point

Layer	VES 6 Resistivity (Ωm)	Depth to Top(m)	Thickness (m)	Infer Lithology	Remarks
1	465	1.36	1.36	Laterite	Weathered
2	995	11.3	9.95	Sand	Dry
3	410502	-	-	Laterite	Unsaturated

Table 13: Summary of table showing Dar Zarrouk Parameters of the Geo-electric Layers, RRC, RC, Thickness and Curve types

VES Stations	T (Ohm-m^2)	S (mho)	Resistivity/Lithology of Potential layers (Ohm-m)	H (m) (thickness)	S (capacity rating)	RRC	RC	Curve type
1	690310	0.002	198/ layer 4-Sandclay	Infinity	Poor	0.90	0.01	A
2	88046	0.11	613/ layer4-Sand	54.4	Poor	0.80	9.5	HK
3	23742	0.01	No potential	-	Poor	0.60	4.4	A
4	63116	0.01	No potential	-	Poor	0.30	2.0	A
5	542540	0.01	No potential	-	Poor	0.62	4.27	K
6	731	0.01	995/layer2-Sand	9.95	Poor	-0.95	0.02	A

Table 14: Aquifer Capacity Rating

Total Longitudinal Conductance Longitudinal CT(mho)	Aquifer Capacity rating
>10	Excellent
5-10	Very good
0.7-4.9	Good
0.2-0.69	Moderate
0.1-0.19	Weak
<0.1	Poor

Table 15: showing curve types of VES points

CURVE TYPES		
VES 1	A – type	σ1<σ2<σ3
VES 2	HK –type	σ1>σ2<σ3>σ4
VES 3	A-type	σ1<σ2<σ3
VES 4	A –type	σ1<σ2<σ3
VES 5	K-type	σ1<σ2>σ3
VES 6	A –type	σ1<σ2<σ3

Conclusion: Results obtained from this survey using Schlumberger Array, revealed the most dependable aquifer bearing zone and the lateral and vertical variation of subsurface lithology with distance and depth respectively. Results also revealed that the surveyed region has a subsurface generally characterized by laterite, which does not favor factors which will evolve a high yielding aquifer. Finally, Schlumberger array is recommended to probe for availability of groundwater compared to other methods because it gives a better vertical sounding and deeper depth probe.

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