International Research Journal of Natural Sciences
Vol.9, No.1, pp.47-60, 2021
Print ISSN: ISSN 2053-4108(Print),
Online ISSN: ISSN 2053-4116(Online)

DELINEATING GROUND WATER POTENTIAL USING ELECTRICAL RESISTIVITY METHOD IN ADAMAWA STATE UNIVERSITY PERMANENT SITE, MUBI NORTH –EASTERN NIGERIA.

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ABSTRACT: *Delineating ground water potential using electrical resistivity method in Adamawa State University permanent site, Mubi North – Eastern Nigeria was carried out to determine depth to the groundwater potential zones, the lithology of the area and possible best site for drilling bore holes. Ten VES points were sounded in the study area with the ABEM SAS 1000 Terameter. The maximum electrode spacing was 100m.Schlumberger array was used during the acquisition of data. Two methods were also used for interpretation of the result which are qualitative and quantitative methods, 1XD interpex software was used to interpret the raw data. Possible groundwater potential areas were detected. Out of the ten VES points; VES 11,12 and 20 were found to be potential zone for ground water exploration due to the presence of fracture/weathered zone and low resistivity, it has a depth ranging from 40m to 70m while VES points 13,14, 15,16,17,18 and 19 do not possess ground water potentials because they have high resistivity values.*

KEYWORDS: Groundwater, vertical electrical sounding (VES), Terameter, Lithology and Schlumberger array.

INTRODUCTION

Water is one of the essentials that supports all forms of plant and animal life (Vanloon and Duffy, 2005) and it is generally obtained from two principal natural sources; Surface water such as fresh water lakes, rivers, streams, etc. and Ground water such as borehole water and well water (McMurry and Fay, 2004; Mendie, 2005). Water is probably the most important resource in the world, since without it life will be non-existence and industrial activities cannot take place. It plays a vital role in the development of communities becau..\..\..\Program Files\Google\Drive File Stream\54.0.2.0\html\ic_close_grey600_24dp.svgse a reliable supply of water is an essential pre-requisite for establishment of a permanent community. Groundwater is a mysterious nature's hidden treasure. Its exploration and exploitation have continued to remain an important issue due to its unalloyed needs. Though there are other sources of water, like streams, rivers, ponds, etc., none is as hygienic as ground water because

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groundwater has an excellent natural microbiological quality and generally adequate chemical quality for most uses (Okpoli, 2017).

Study of groundwater geology is much useful for all the activities of human life. Groundwater is more advantageous than the surface water. Water scarcity problem affects the human chain and other living things. To meet out the demand of water, people are depending more on aquifers (Srinivasan *et al.,* 2013). There are two end members in spectrum of types of aquifers; confined and unconfined (with semi confined aquifer being in between them) (Niwas, 2003).

A lot of research work has been carried out in finding groundwater successfully using geophysical methods (Worthington,1977; Olorunfemi *et al.*, 1999; Olorunfemi *et al.*, 1993, Akintorinwa and Olowolafe, 2013, Mogaji *et al.*, 2011) and/or remote sensing method (Odeyemi *et al.*, 1999,Mogaji *et al.*, 2011, Anifowose and Kolawole, 2012,Yenne, 2015, Dibal *et al*, 2016). Exploration for groundwater requires a vivid understanding of both surface and subsurface characteristics of the area (Mogaji *et al.*, 2011).

This research is aimed at Delineating Ground Water Potential Using Electrical Resistivity Method In Adamawa State University Permanent Site , Mubi North – Eastern Nigeria. The objectives are: to determine possible best site for drilling bore hole, Lithology of the area (apparent resistivity, thickness of layers and the depth to bedrock), as well as fractured zones.

The study area

The area lies within Latitude 10^0 015'N and 10^0 025′N and Longitude 13^0 015'E and 13^0 025′E. The area is $10km^2$ and is quite accessible. The topography of the area is typically of steep hills, undulating slopes and gentle escarpment. The landform is the consequence of geological and geomorphological processes.

The town is located within the Precambrian Basement Complex in the Northern part of Adamawa State. The rocks in the area are the Migmatite-gneisses and the Older granites. Some parts of the study area overlying the basement rocks are the alluvial deposits,which are derived from the weathering of the basement rock uphill and in situ. Geologic log data indicate that the thickness of the alluvial deposits to the bedrock range from about 5m to 25m along the river Yedsarem. The area is made up of two aquifer systems based on geological reconnaisance, the nature of the water and analysis of borehole lithologic logs. These are the fractured basement mainly magmatic (Obiefuna *et al.*, 1999).

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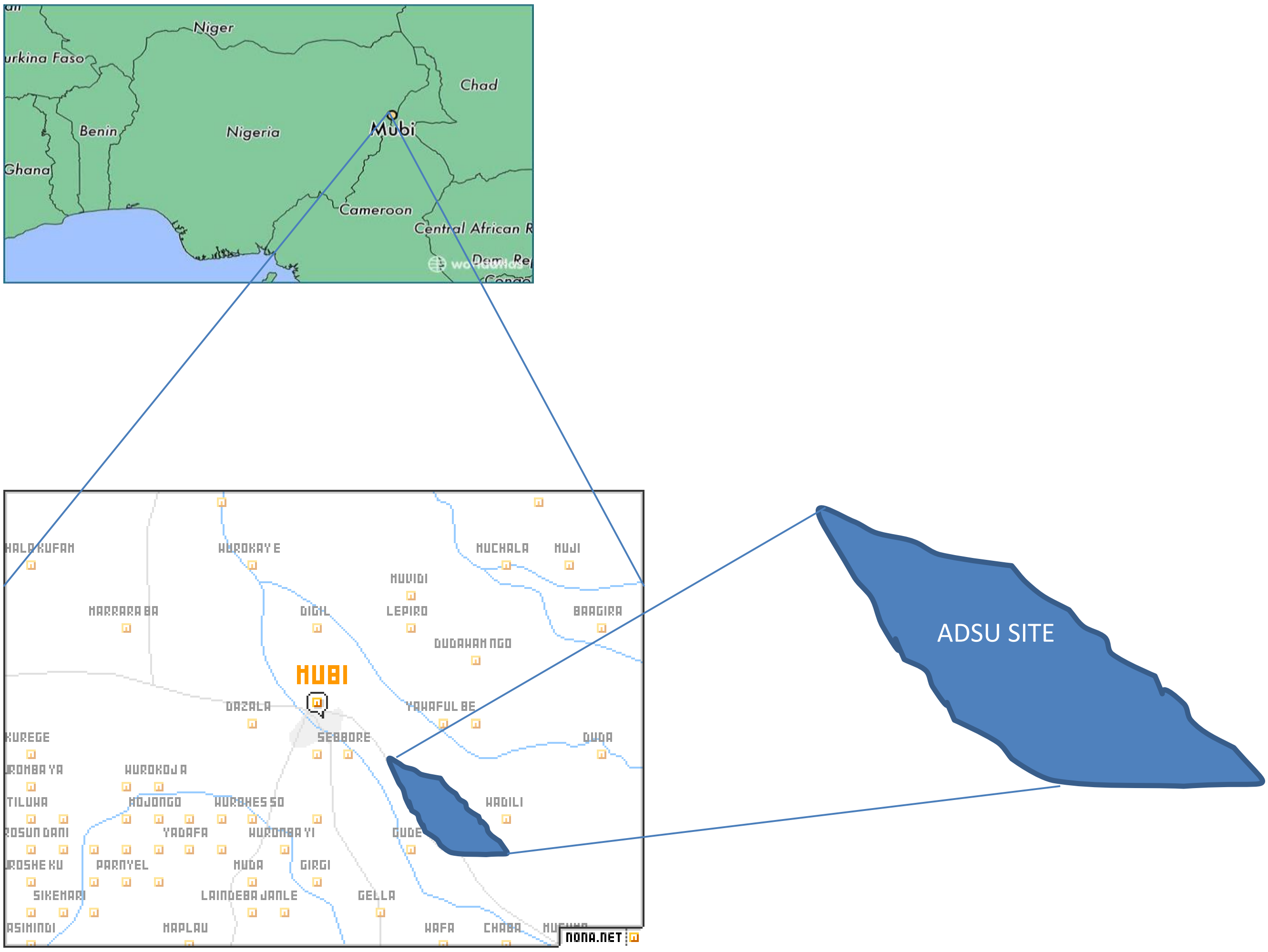

Fig. 1: Location map of the study area

LITERATURE REVIEW

A lot of research work had been carried out on underground water exploration around the world. Brousse (1963) cited the effectiveness of the electrical resistivity method in the investigation for groundwater in complex granite areas. He used the method to map fractures, gorges gouge, and faults which act as water reservoirs. The Basement complex is generally a poor source of groundwater because the decomposed mantle is often too thin to harbor large quantities of water and sometimes too clayey to be highly permeable or the joints and fractured zones are poorly developed (Olorunfemi,1993).

Nggada and Nur, (2017) Used Schlumberger method to carry out Geo-electrical Survey for Ground water Potential of Biu and Environ, North Eastern Nigeria and concluded that Vertical Electrical Sounding (VES) has proved useful evaluating the ground water potential within and around Biu.

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https://doi.org/10.37745/irjns.13

Print ISSN: ISSN 2053-4108(Print),
Online ISSN: ISSN 2053-4116(Online)

Kasidi and Lazarus (2017) Application of vertical electrical sounding (VES) delineating ground water potentials in some part of Jalingo , Taraba state North eastern Nigeria and were able to locate the ground water potential zones .

Mohammed *et al.* (2007) In a regional geo-electrical investigation for groundwater exploration in Minna Area North west Nigeria, the result from this study has provided a useful guide towards locating sites of productive bore hole

MATERIALS AND METHODS

The geophysical methods adopted for this research was Vertical Electrical Sounding using the equipments ABEM SAS-1000 Terameter, electrodes, wire, car battery , umbrella, hammer and tape. Schlumberger array of the electrical resistivity method was used in carrying out the geophysical survey. Apparent resistivity measurements were made by systematically varying electrode spacing. A total of 5 VES points were occupied on the study area with maximum electrode spacing of 100m.The Vertical Electrical Sounding which is a 1-D resistivity approach was used to measure the vertical variations in electrical properties beneath the earth surface using the Schlumberger electrode configuration. It involves the use of a pair of current electrodes and a pair of potential electrodes to measure the resultant potential difference within the subsurface. Data are obtained by increasing the electrode spacing linearly about a central position whose vertical resistivity variation is sought.

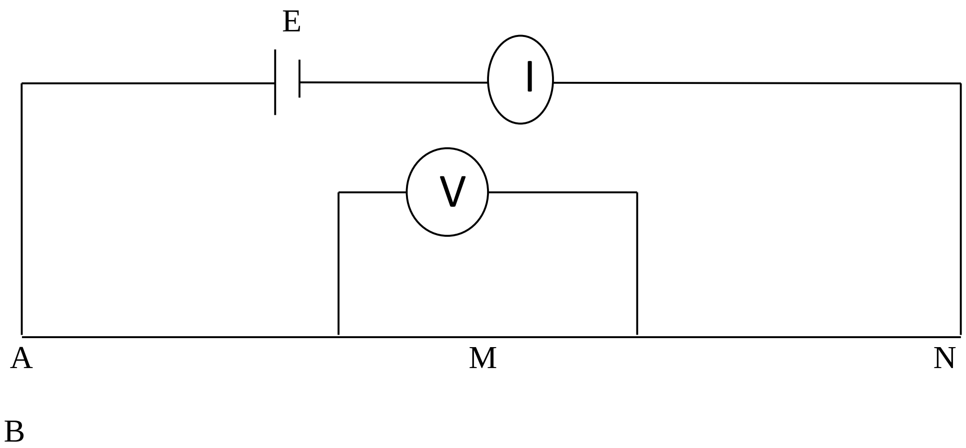

Fig. 2: Schlumberger Configuration

Resistance measurements are made at each expansion and multiplied by the respective geometric factor (K) to give the apparent resistivity of the point using the equation;

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

Where

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

ρ_a is apparent Resistivity, K is Geometric Factor, V is Voltage, I is Current, R is Resistance, AB is the Current Electrode Separation and MN is potential electrode separation. During data acquisition the electrodes were connected appropriately to their respective terminals on the Terameter through cables and hammered to make good contact with the earth. During the sounding, the instrument sends down direct current into the earth subsurface through the pair of steel current electrodes, while the established subsurface potential difference across the subsurface under investigation was measured by the Terameter through the steel potential electrodes. For each sounding, the Terameter computes and displays a mean digital value of the apparent resistivity of the subsurface under investigation (Lazarus *et al.*, 2020).

RESULT

The apparent resistivity data were processed by Interpex IXD resistivity software using one dimensional (1D) inversion to model the vertical variations of subsurface resistivity at different depths. This software allows the user to enter apparent resistivity data in a standard geo-soft format. It also smoothens the field curve through the process of filtering technique that involves single point correction and vertical curve segment shift. This package is capable of converting the values of apparent resistivity as function of electrode spacing acquired as the field data to values of true resistivity as function of depth of individual layer for the actual condition in the ground to be interpreted. The result of the interpreted data is presented in the table below and their graphical representations.

VES NO	NO OF LAYERS	ρa(ohm-m)	Thickness	Depth	Lithology
11	1	150	3.0		Top soil
	2	0.3	0.6	3.0	Weathered basement
	3	16000		3.6	Fresh basement
12	1	180	1.4	-	Top soil
	2	2.0	0.4	1.4	Milled fracture
	3	700	-	1.8	Fresh basement
13	1	20	2.9	-	Top soil
	2	1.5	0.3	2.9	Weathered basement
	3	900	-	3.2	Fresh basement
14	1	200	4.4	-	Top soil

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	2	2.8	0.2	4.4	Weathered basement
	3	240	-	4.6	Fresh basement
15	1	170	18	-	Top soil
	2	4.0	1.0	18	Fresh Weathered
	3	310	-	19	Fresh basement
16	1	25	3.0	-	Top soil
	2	8	0.1	3.0	Weathered basement
	3	50000	-	3.1	Fresh basement
17	1	30	20	-	Top soil
	2	50000	-	20	Fresh basement
18	1	60	2.2	-	Top soil
	2	12	0.1	2.2	Weathered basement
	3	100600	-	2.3	Fresh basement
19	1	270	8.2	-	Topsoil
	2	150000	-	8.2	Fresh basement
20	1	500	2.6	-	Top soil
	2	5.0	0.1	2.6	Weathered basement
	3	200,000	-	2.7	Fresh basement

Table 1: Result interpretation of VES 11 to VES 20

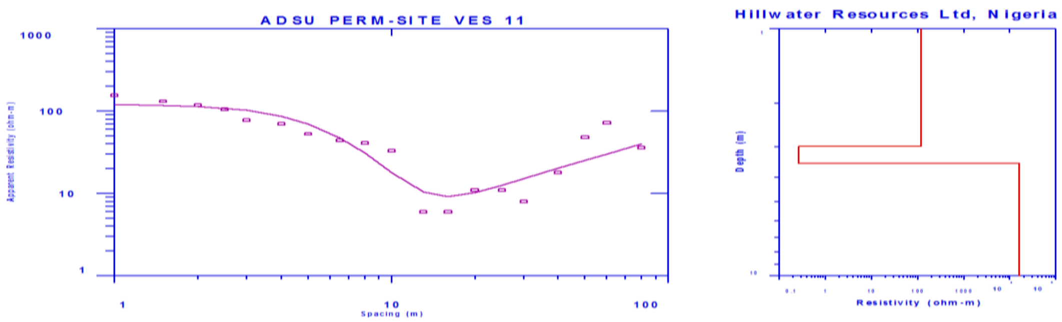

Fig 3: Graphical interpretation of VES 11.

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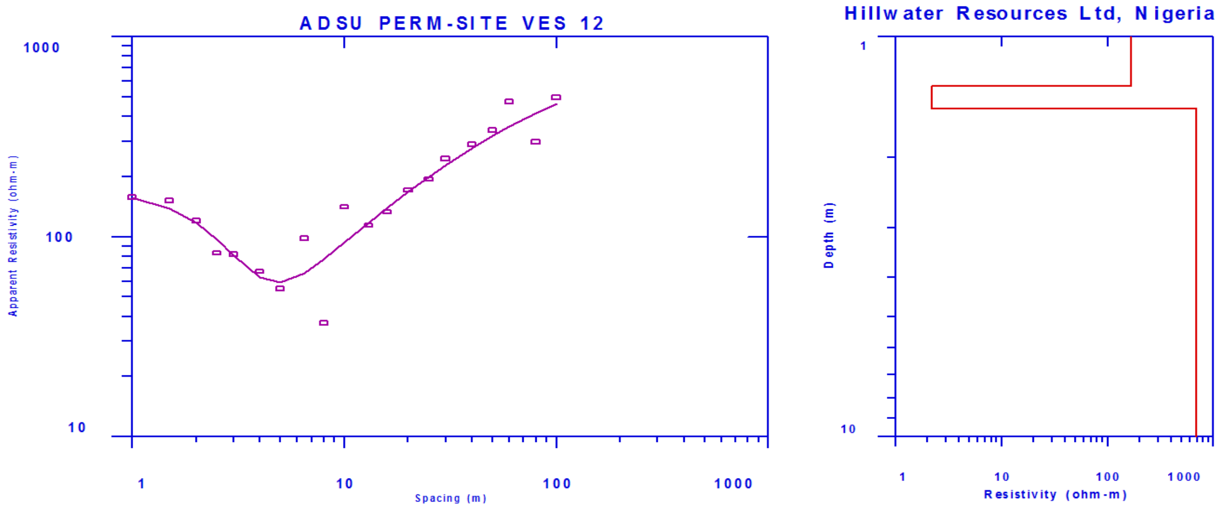

Fig 4: Graphical interpretation of VES 12.

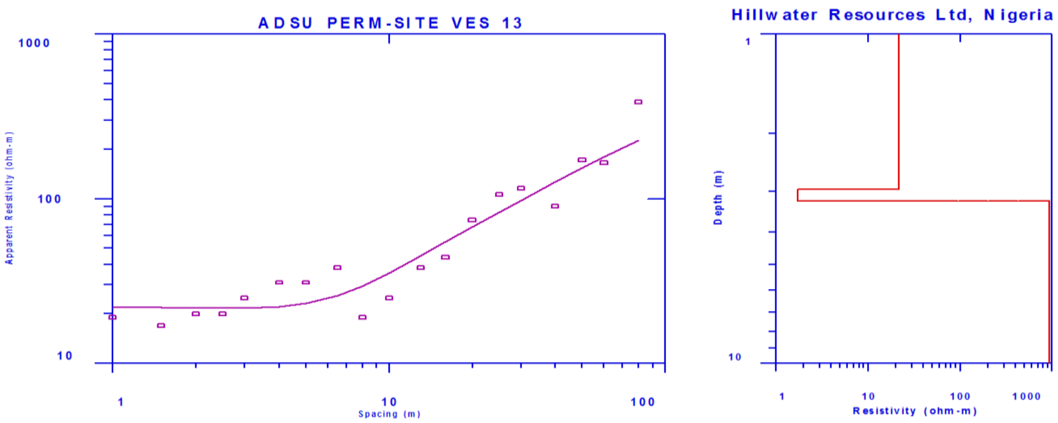

Fig 5: Graphical interpretation of VES 13.

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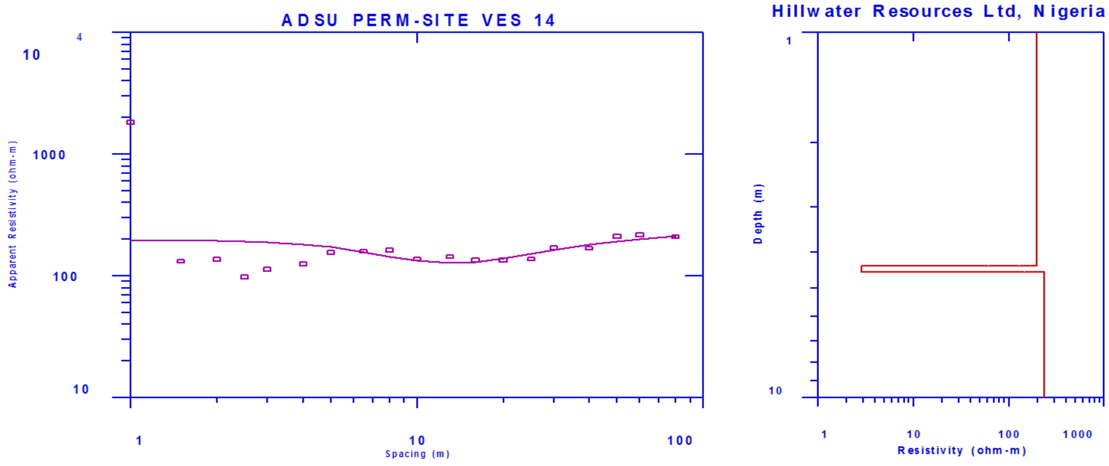

Fig 6: Graphical interpretation of VES 14.

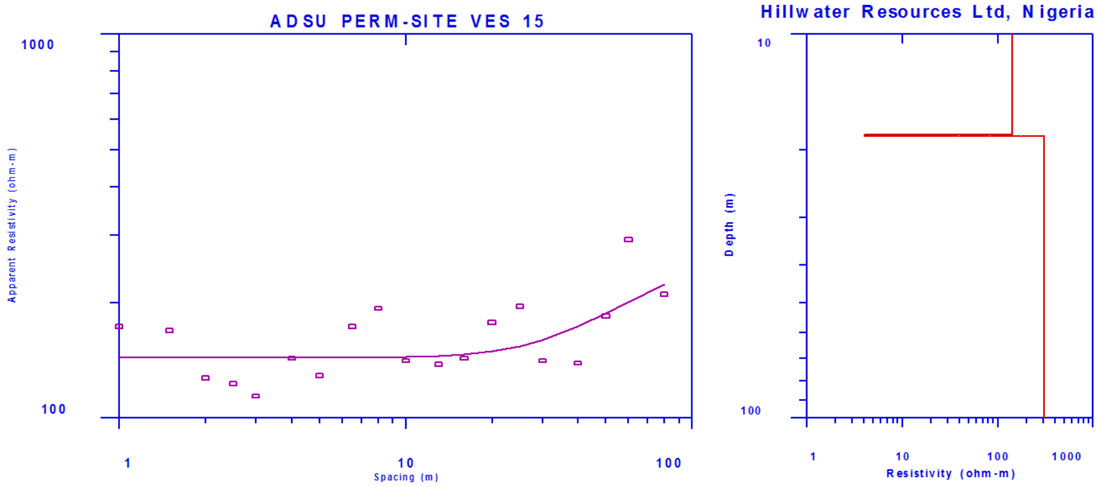

Fig 7: Graphical interpretation of VES 15.

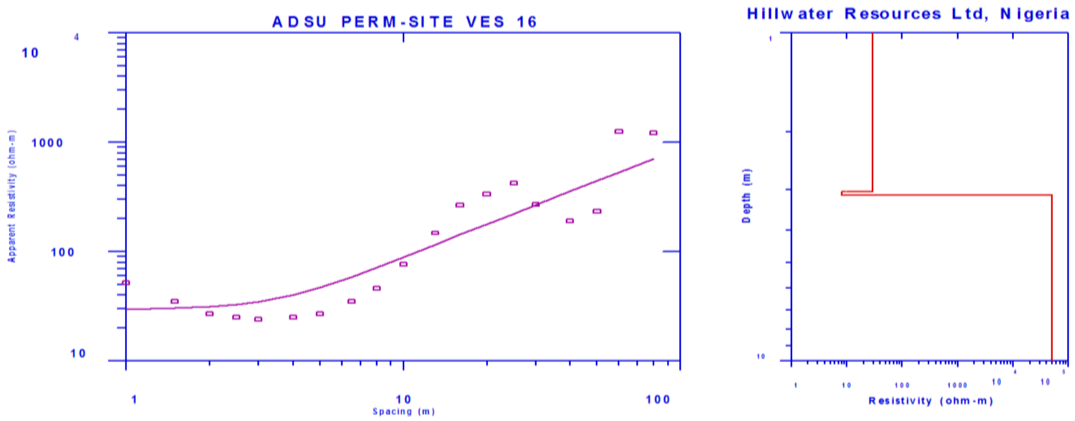

Fig 8: Graphical interpretation of VES 16.

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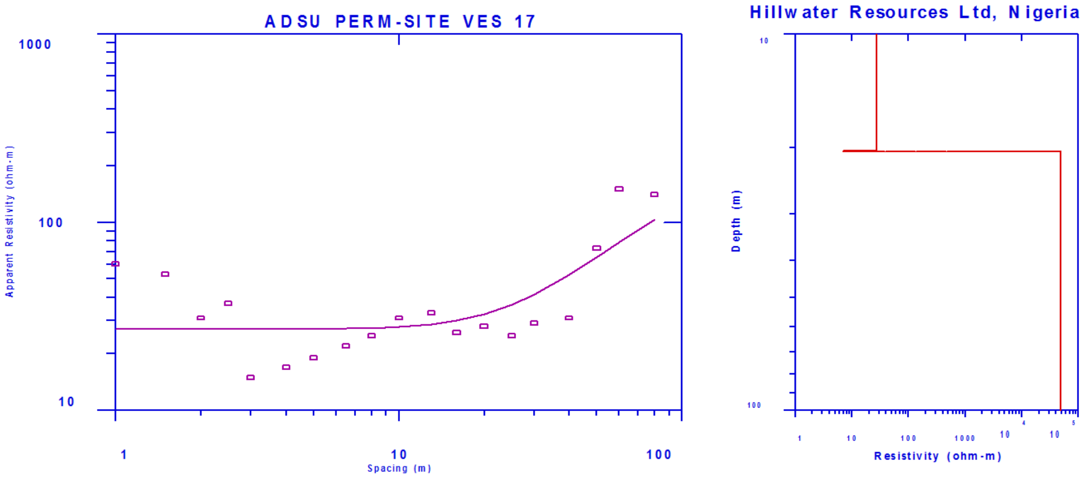

Fig 9: Graphical interpretation of VES 17.

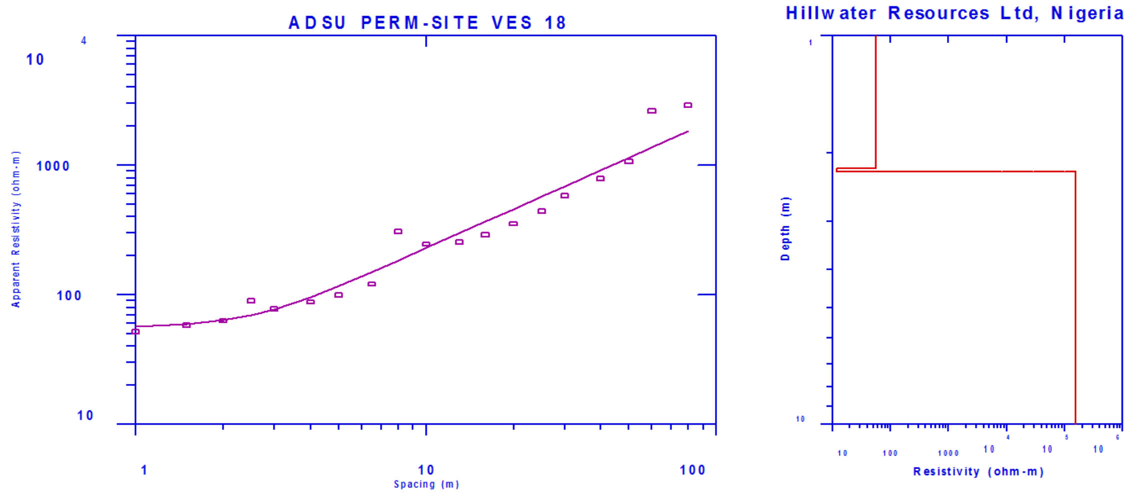

Fig 10: Graphical interpretation of VES 18.

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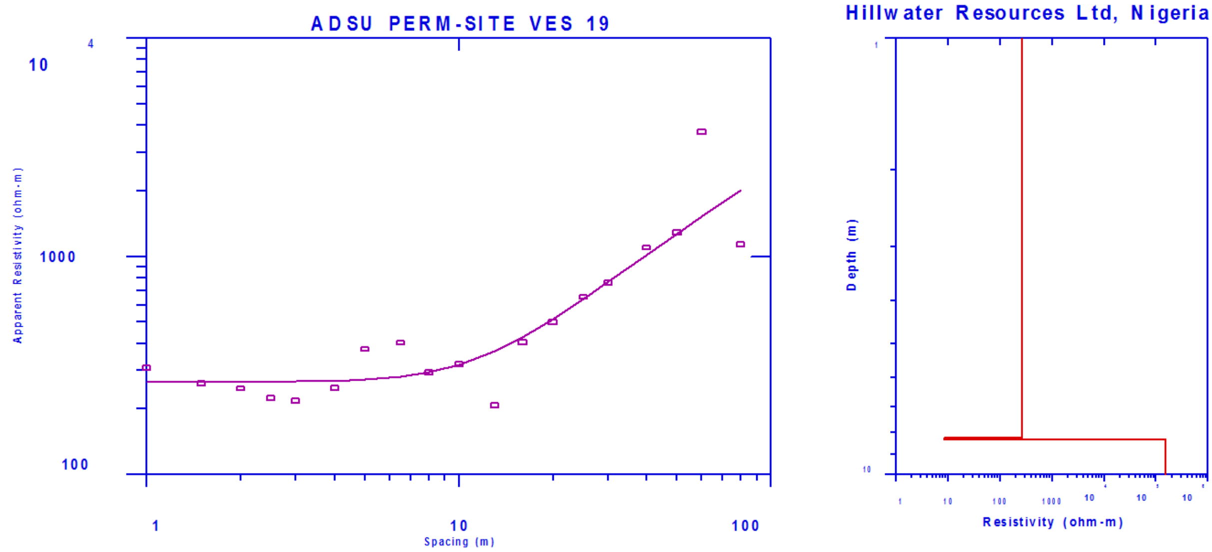

Fig 11: Graphical interpretation of VES 19.

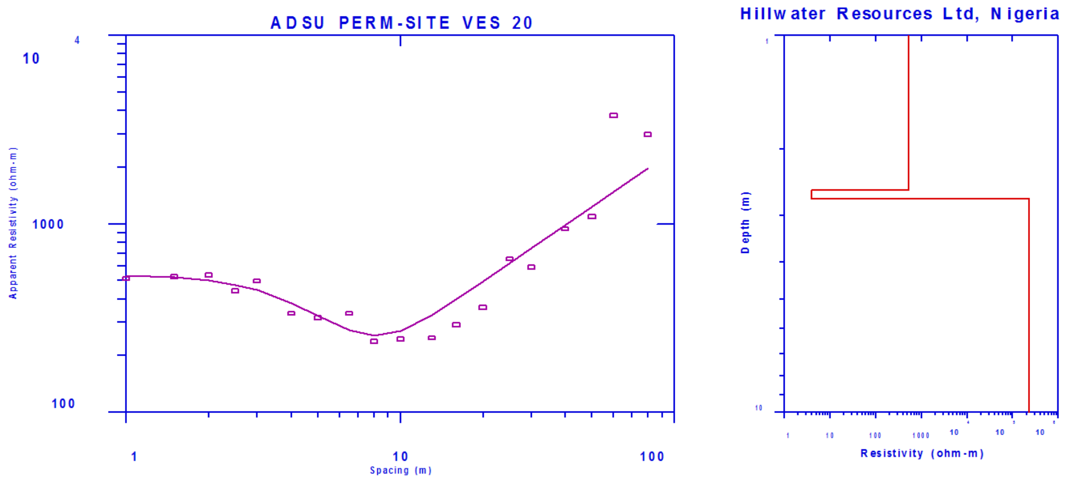

Fig 12: Graphical interpretation of VES 20.

DISCUSSION OF THE RESULT

The geoelectric section of VES 11 indicates three geoelectric layers. It's apparent resistivity curve is the H-Type, with $p_1 > p_2 < p_3$. The first layer has a resistivity value of $150\Omega m$ with thickness of 3.0m at the top soil. The second layer has resistivity value of $0.3\Omega m$ with thickness of 0.6m at the weathered basement. The third layer has resistivity of $16{,}000\Omega m$ and it is suspected to fresh basement.

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Vol.9, No.1, pp.47-60, 2021
Print ISSN: ISSN 2053-4108(Print),
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The geoelectric section of VES 12 indicates three geoelectric layers and it's apparent resistivity curve is the H-Type with, $p_1 > p_2 < p_3$ The first layer has a resistivity value of 180Ωm with thickness of 1.4m at the top soil. The second layer has resistivity value of 2.0Ωm with thickness of 0.2m at the mild fracture. The third layer has resistivity of 700Ωm and it is suspected to be fresh basement.

The geoelectric section of VES 13 indicates three geoelectric layers and it's apparent resistivity curve is the A-Type, with $p_1 > p_2 < p_3$. The first layer has a resistivity value of 20Ωm with thickness of 2.9m at the top soil/moist. The second layer has resistivity value of 1.5Ωm with thickness of 0.3m at the weathered basement. The third layer has resistivity of 900Ωm and it is suspected to be fresh basement.

The geoelectric section of VES 14 indicates three geoelectric layers and it's apparent resistivity curve is the H-Type, with $p_1 > p_2 < p_3$. The first layer has a resistivity value of 200Ωm with thickness of 4.4m at the top soil. The second layer has resistivity value of 2.8Ωm with thickness of 0.2m at the weathered basement. The third layer has resistivity of 240Ωm and it is suspected to be fresh basement.

The geoelectric section of VES 15 indicates three geoelectric layers and it's apparent resistivity curve is the A-Type, with $p_1 > p_2 < p_3$. The first layer has a resistivity value of 170Ωm with thickness of 18m at the top soil. The second layer has resistivity value of 4.0Ωm with thickness of 1m at weathered basement and the third layer has resistivity of 310Ωm and it is suspected to be fresh basement.

The geoelectric section of VES 16 indicates three geoelectric layers and it's apparent resistivity curve is the A-Type, with $p_1 > p_2 < p_3$. The first layer has a resistivity of 25Ωm with thickness of 3.0m at the top soil. The second layer has resistivity of 8Ωm with thickness of 0.1m at weathered basement. The third layer has resistivity of 50,000 Ωm and it is suspected to be fresh basement.

The geoelectric section of VES 17 indicates two geoelectric layers and it's apparent resistivity curve is the A-Type, with $p_1 < p_2$.The first layer has a resistivity of 30Ωm with thickness of 20m at the top soil. The second layer has resistivity of 50,000Ωm and it is made up of fresh basement

The geoelectric section of VES 18 indicates three geoelectric layers and it's apparent resistivity curve is the A-Type, with $p_1 > p_2 < p_3$. The first layer has a resistivity of 60Ωm with thickness of 2.2m at the top soil. The second layer has resistivity of 12 Ωm with the depth of 0.1m at weathered basement. The third layer has resistivity of 100,600Ωm with a thickness of 7.7m and it is suspected to be made up fresh basement.

The geoelectric section of VES 19 indicates two geoelectric layers and it's apparent resistivity curve is the A-Type, with $p_1 < p_2$. The first layer has a resistivity of 270Ωm with thickness of 8.2m at the top soil. The second layer has resistivity of 150,000Ωm and it is made up of fresh basement

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https://doi.org/10.37745/irjns.13

Print ISSN: ISSN 2053-4108(Print),
Online ISSN: ISSN 2053-4116(Online)

The geoelectric section of VES 20 indicates three geoelectric layers and it's apparent resistivity curve is the H-Type, with $p_1 > p_2 < p_3$. The first layer has a resistivity of $500\Omega m$ with thickness of 2.6m at the top soil. The second layer has resistivity of $5.0\Omega m$ with the depth of 0.1m at weathered basement. The third layer has resistivity of $200{,}000\Omega m$ with a thickness of 7.3m and it is suspected to be made up of fresh basement.

Implication to research and practice

Base on the research finding it was observed that the area under study did not have adequate potential zones for ground water exploration. Only three VES points has potential zone for groundwater exploration which may be used for hand dug wells. The good part of the findings is that money should not be invested in bore hole drilling on the area under study.

In practice some of the areas that are potential zones can be explored base on the water beneath the ground surface.

CONCLUSION

A delineation of groundwater potential using Electrical Resistivity method to determine the depth and geo-electric units at Adamawa State University Permanent Site , Sauda Road , Mubi North-Eastern Nigeria, was carried out, Vertical Electrical Sounding (VES) method was used Schlumberger array has proved to be effective. Analysis of the interpreted result has shown the nature and sub-surface lithology unit. Thus, this includes the top soil, Alluvium, Weathered basement and Fresh basement. Base on the resistivity values of the area ,the potential zones for groundwater exploration has been identified which include VES 11,12 and 20 possess low resistivity values, while VES 13,14,15,16, 17,18 and19 do not possess groundwater potentials because of high resistivity values.

Future Research

Intergraded geophysical method could be used for future research on the study area.

Acknowledgment

We appreciate the TETFUND for sponsoring this research wok and management of The Federal Polytechnic Mubi Adamawa State North-Eastern Nigeria for given us the opportunity to access the fund.

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