Journal of Physical Science and Innovation
ISSN: 2277-0119
Volume 9, No. 3, 2017

THE APPLICATION OF RESISTIVITY METHOD, VERTICAL ELECTRICAL SOUNDING (VES) FOR THE LOCATION OF GOOD GROUNDWATER POTENTIAL AT THE FEMALE HOSTEL, FEDERAL UNIVERSITY DUTSINMA PERMANENT SITE

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ABSTRACT

A Geophysical survey was carried out to investigate groundwater potential at the permanent site in female hostel of Federal University Dustin-ma, Katsina State Nigeria. The aim of the investigation is to explore the groundwater potential of the area with the objectives of determining the depth to basement, the depth and thickness of aquifer, the thickness of the weathered basement, the variation in resistivity of the overburden and for other, properties such as sediments at which portable groundwater can be obtained. The geo-electrical methods used in the survey were the Vertical Electrical Sounding (VES) and Horizontal profiling. Five (5) VES were conducted using the Schlumberger configuration and Horizontal spread covering the entire area. The Horizontal Profiling data was carried out to obtain the lateral variation in resistivity. Based on the interpretation of the profiling data, areas with low resistivity were sounded along the traverse. The VES data were interpreted using geophysical software IPI2Win which showed that the area is composed of four layers namely; topsoil, weathered basement, fractured basement and fresh basement. Based on the interpretation of the VES points the depth to basement varies from 10.2 to 63.1m, the thickness of the aquifer varies from 2.34 to 62.2 m and it depths varies from 10.2 to 62.2 m, the resistivity of the overburden (topsoil) varies from 31.3 to 977 Ωm, the thickness of the weathered basement varies from 5.21 to 36.7 m. Contour maps were plotted using the SURFER 10 computer software showing all the topsoil resistivity, aquifer thickness and depth to basement at each VES point. Based on all the

correlated data and information the following points VES 02, VES 04 and VES 05 are highly recommended for suitable groundwater establishment.

Keywords: Resistivity, Borehole, Vertical Electrical Sounding, Groundwater

INTRODUCTION

The availability of safe and portable water in an environment is a veritable index of tremendous role to the development and growth of an environment. Water is considered to be important for the sustenance of life .This is why nature has bestowed the world with much of it. About two third of the total land space in the world is covered by it (Shiklomanov, 1993).However the availability of good quality water for drinking has been characterized with problems ranging from pollution to inadequate information to exploit it for use. Water is available in many forms such as ice caps, glaciers, oceans water, surface water and ground water, groundwater happens to be a more reliable source of water for over half of the world population (Alabi *et al.,* 2010, and Anomohanran, 2011a). The choice of method depends largely on the depth of investigation and sometimes cost (Todd, 2004; Majumdar and Das, 2011).The use of geophysical methods in ground water exploration involves the delineation of potential aquifers and geological situations favorable for the occurrence of good water (Akpaneno, 2014).

Underground water is characterized by a certain number of parameters which are determined by geophysical methods such as electrical resistivity methods, seismic methods, magnetic methods, gravity methods etc. But for this research work, the application of electrical resistivity survey method was used. The most usual parameters are the porosity, the permeability, the transmissivity and the conductivity. The Vertical Electrical Sounding (VES) is a common geophysical technique in groundwater exploration. It is used to determine the vertical variation of electrical resistivity below the earth surface and the potential field generated by the current (Otobo and Ifedili, 2005; Anomohanran, 2011a). It is based on the fact that the electrical resistivity of

most rocks depends on the amount of water in their pores. It also depends on the distribution of these pores and the salinity of the water (Todd, 2004). With the prevailing need for water in the study area coupled with lack of surface water sources, there has been greater interest to search for areas of good water potential. This study is therefore aimed at locating areas of good ground water potential. This will be done by evaluating the geoelectrical and hydrogeological characteristics of the aquifer layer present in the study area. This study will therefore provide the needed information to the university communities with best locations for obtaining portable water.

LOCATION AND EXTENT OF SURVEY AREA

Dutsinma LGA lies on latitude 12°26'N to 12°28'N and longitude 07°29'E to 07°31'E (Figure). It is bounded by Kurfi and Charanchi LGAs to the north, Kankia LGA to the east, Safana and Dan-Musa LGAs to the west, and Matazu LGA to the southeast. Dutsinma LGA has a land size of about 552.323 km^2 with a population of 169 829 as at 2006 national census (Federal Republic of Nigeria, 2012). The people are predominantly farmers, cattle rearers and traders. The study area is located within the Federal University Dutsinma permanent site (Figure 2). It lies on longitude 07°26'E - 07°27'E and Latitude 12°17'N - 12°18'N.

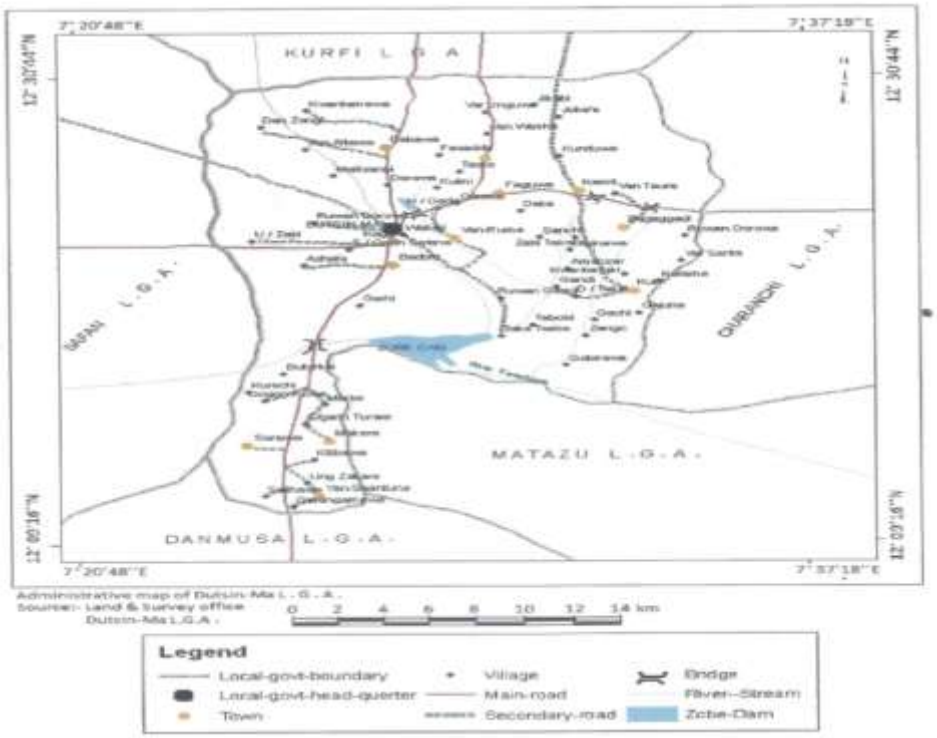


Figure.1: Map of Dutsinma Showing the Survey Area (Adapted from Land and Survey Office Dutsinma L.G.A 2012.)

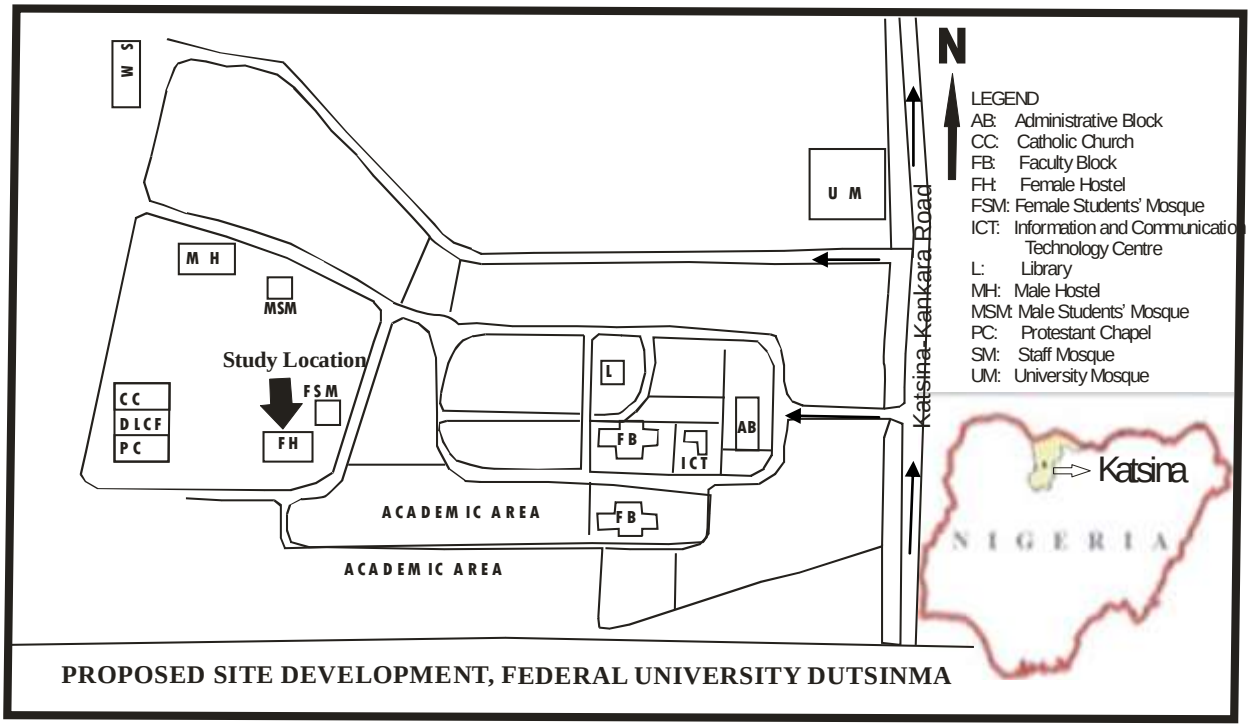


Figure 2: Map showing interconnection between various sections of FUDMA campus and the study Location (Adapted from the Dept. of Works and Planning, FUDMA; modified).

Geology of the Study Area

Dutsinma just as the name implies in Hausa language 'stone' is underline by basement complex area constituting of older granite (more than 600 million years), pre-protozioc old. The older granite is also known as granite suite (Figure 3).

Federal University Dutsinma is underline by meta-sediments which can be formed in two ways;

A).Sediments: Shale → Slates → Plilites → Gneiss → Migmatite.

B).Regional Metamorphism: Granite (older/younger) → Gneiss → Migmatite.

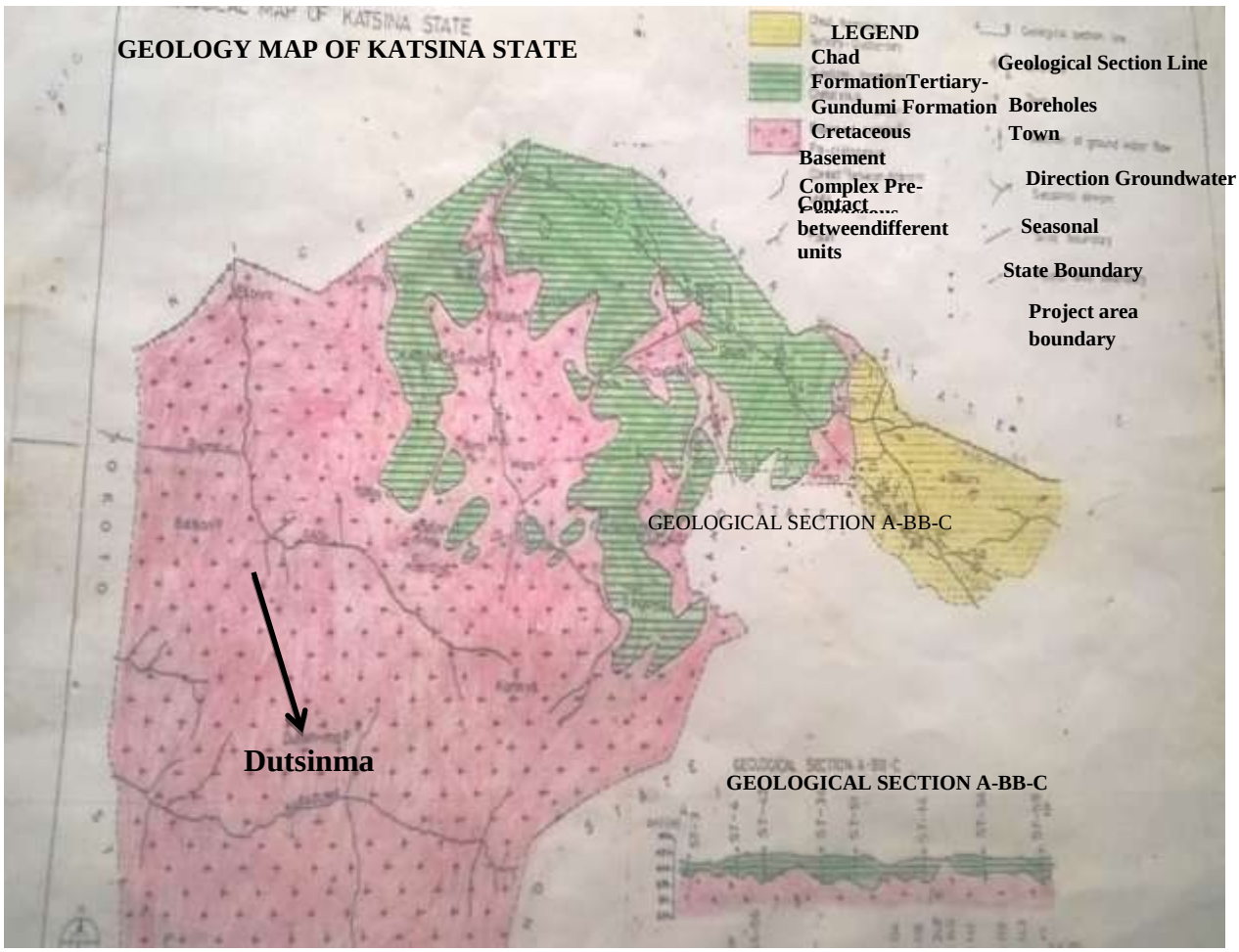


Figure 3: Showing the Geologic map of Katsina Showing Dutsinma (Adapted from GEO-INVEST & BOREWELL (NIG) LTD Katsina; Modified).

Climate and Vegetation

The climate of Katsina State is the tropical wet and dry type (tropical continental climate) classified by Koppen as Aw climate. Rainfall is between May and September with peak in August. The average annual rainfall is about 700 mm. The pattern of rainfall in the area is highly variable. This can result in severe and widespread droughts that can impose serious socio-economic constraints (Abaje, *et al.*, 2012). The mean annual temperature ranges from 29°C – 31 °C. The highest air temperature normally occurs in April/May and the lowest in December through February. Evapotranspiration is generally high throughout the year. The highest amount of evaporation occurs during the dry season. The vegetation of the area is the Sudan Savannah type which combines the characteristics and species of both the Guinea and Sahel Savannah.

METHODOLOGY

The research has utilized the electrical resistivity method in delineating areas of good water potential. The geo-electrical methods used were vertical electrical sounding (VES) and horizontal profiling using SAS 300 Model Terrameter and its accessories. The conventional Schlumberger array pattern with half electrode spacing (AB/2) varying from 1m to a maximum of 100m was used. The apparent resistivity was computed using equation 1

$$\rho_a = KR \quad (1)$$

Where ρ_a is an apparent resistivity

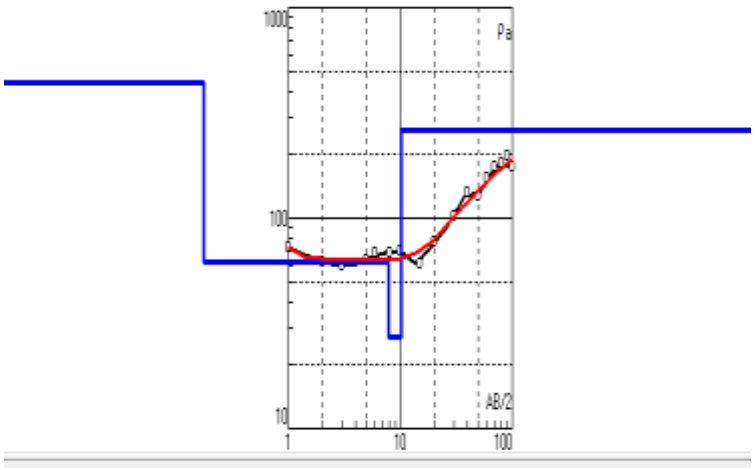
$$R = \frac{\Delta V}{I}, \text{ is the earth resistance} \quad (2)$$

$$K = n\left(\frac{\left(\frac{AB}{2}\right)^2 - \left(\frac{AB}{2}\right)^2}{MN}\right) \text{ is the geometric factor} \quad (3)$$

The apparent resistivity values obtained from equation (s) were plotted against the half current electrode separation spacing using IP!2WIN software. From these plots, vertical electrical sounding curves were obtained (Figure 4) and qualitative deductions such as resistivity of the layers, the depth of each layer, the thickness of each layer and number of layers.

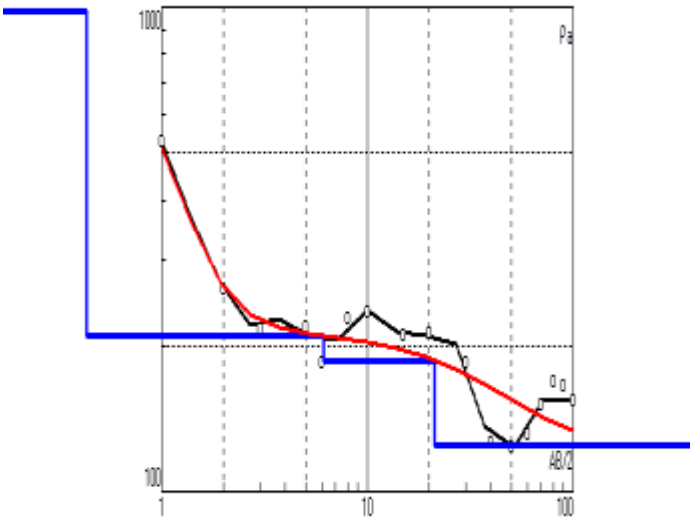
ANALYSIS, RESULTS AND DISCUSSION

The summary of VES points, number of layers, Resistivities, Thickness and Depth of Sub- Surface are presented in Table 1. It also consists of the various VES points. Results from the plots of VES curves in Figure 4a and 4b showed that the area is composed of four layers namely, topsoil, weathered basement, fractured basement and fresh basement. The weathered and fractured layers constitute the aquiferous zone in all the stations. The topsoil of the area is made up of clayey sand, granite, sandstone and sand. Resistivity of the top soil, Aquifer thickness and Depth to basement contour map were produced using SUFER 10 computer software (see Figure 5a, b and c)



N	ρ	h	d	Alt
1	438	0.176	0.176	-0.1764
2	62.2	7.68	7.85	-7.855
3	27	2.34	10.2	-10.19
4	263			

Figure 4a: Graph of VES 01



N	ρ	h	d	Alt
1	977	0.431	0.431	-0.4313
2	210	5.71	6.14	-6.14
3	186	15.1	21.3	-21.26
4	125			

Figure 4b: Graph of VES 02

Table 1: Showing summary of VES points, number of layers, Resistivities, Thickness and Depth of Sub-surface

VES Points	Layers	$\rho(\Omega m)$	h (m)	d (m)
01	1	438	0.176	0.176
	2	62.2	7.68	7.85
	3	27	2.34	10.2
	4	263	-	-
02	1	977	0.431	0.431
	2	210	5.71	6.14
	3	186	15.1	21.3
	4	125	-	-
03	1	31.3	0.117	0.117
	2	1128	0.719	0.837
	3	390	33.1	33.9
	4	12.9	-	-
04	1	55.2	0.392	0.392
	2	1766	0.507	0.899
	3	85.2	62.2	63.1
	4	10421	-	-
05	1	209	2.4	2.4
	2	21.3	1.13	3.53
	3	75.6	49.2	52.7
	4	310	-	-

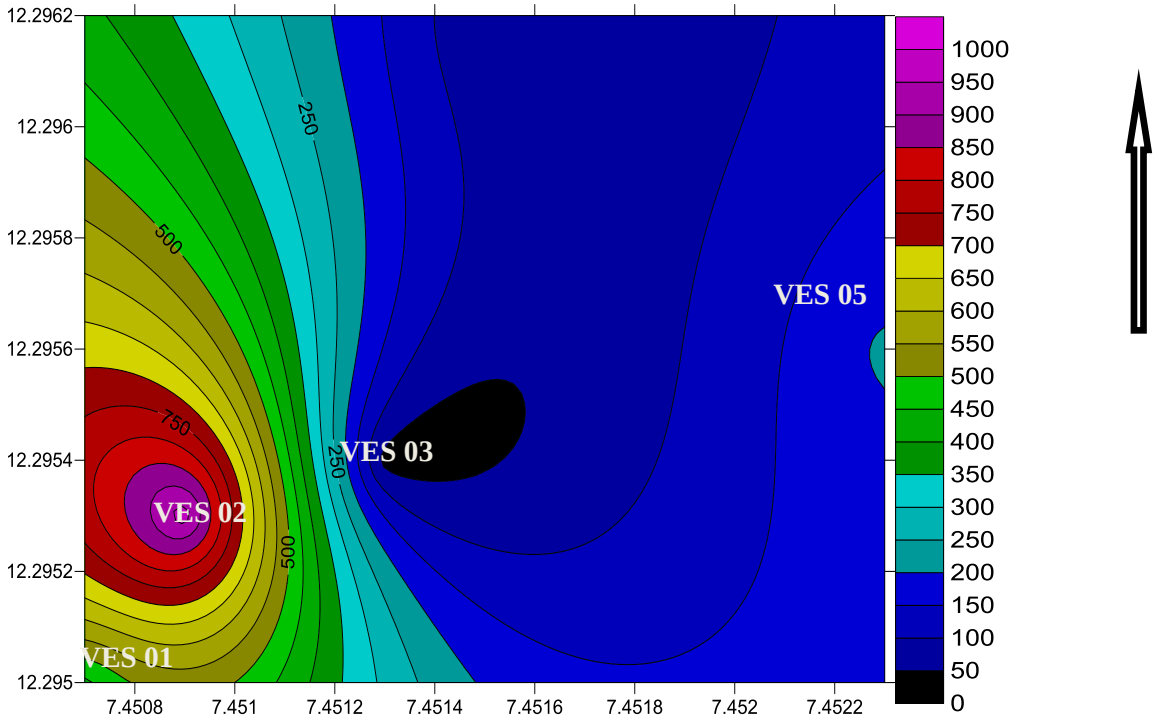


Figure 5a: Resistivity Map for Top Soil Resistivity

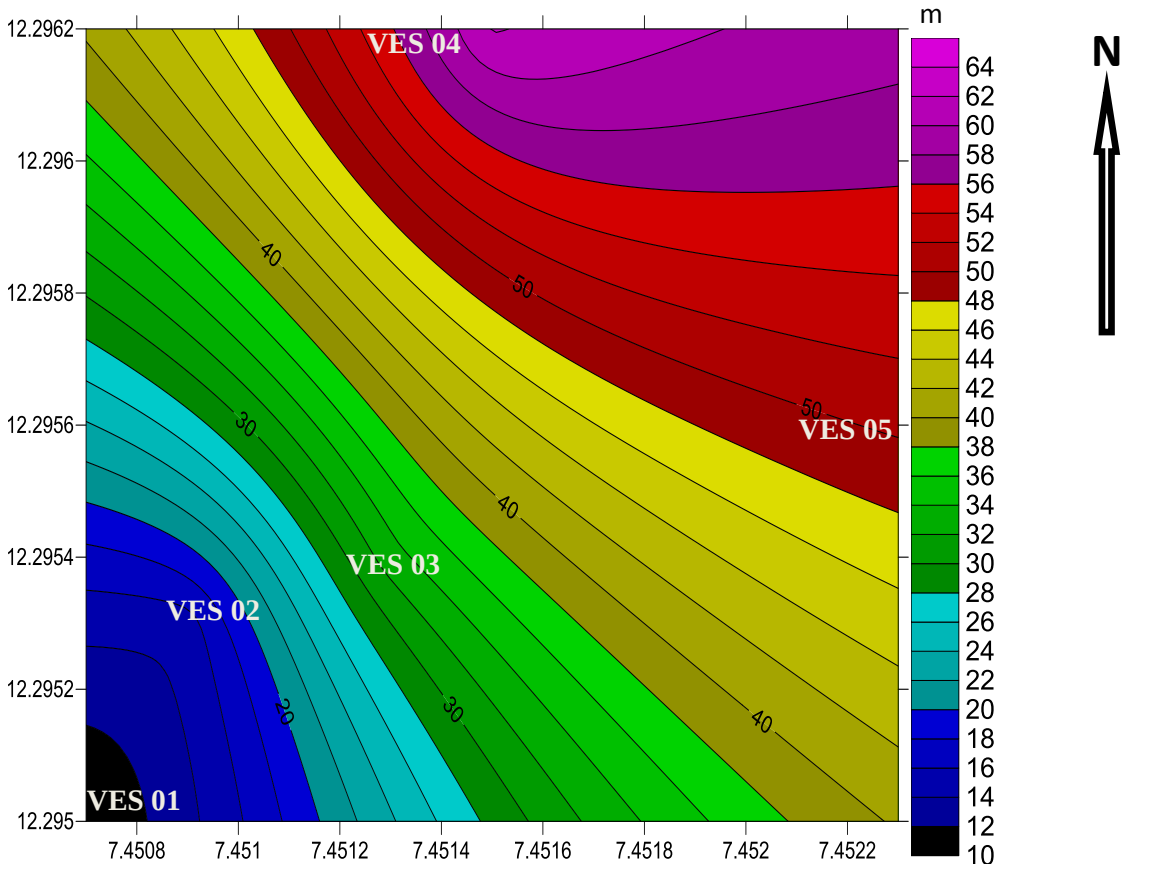


Figure 5b: Resistivity Map for Aquifer Thickness

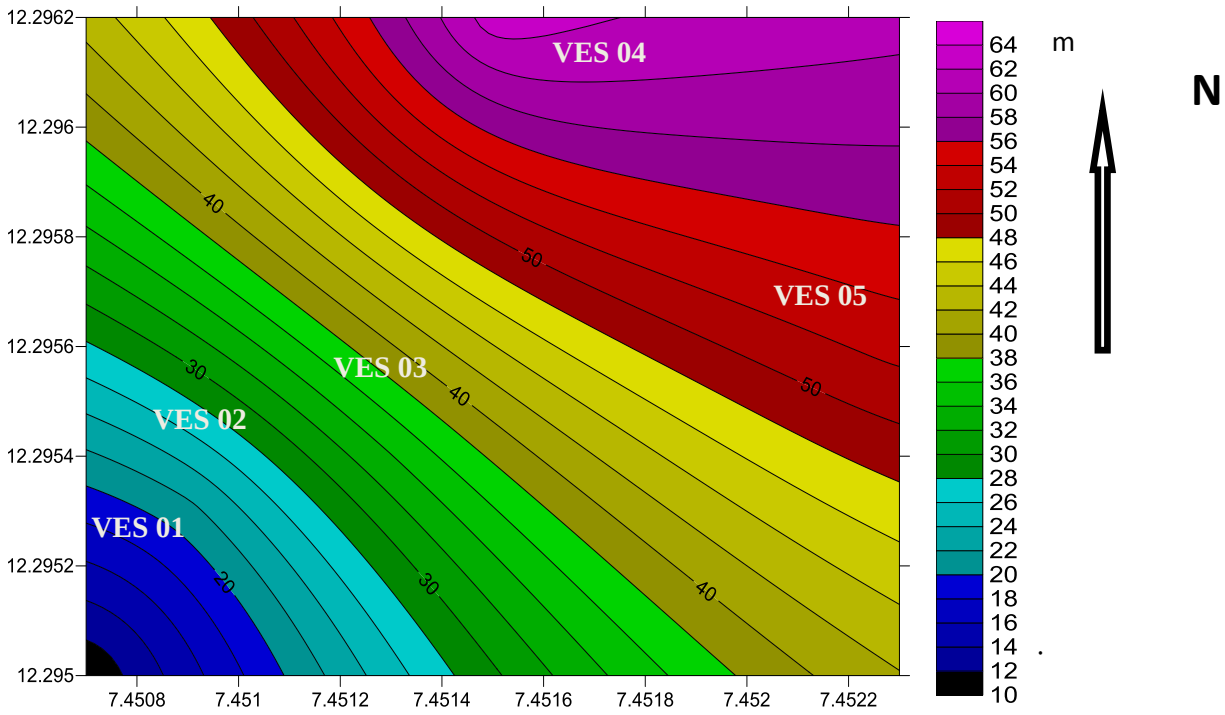


Figure 5c: Resistivity map for Depth to Basement

CONCLUSION

A Geophysical survey was carried out to study groundwater potential at the permanent site in female hostel of Federal University Dustin-ma, Katsina State Nigeria. The aim of the investigation is to explore the groundwater potential of the area. The geo-electrical methods used in the survey were the Vertical Electrical Sounding (VES) and horizontal profiling. Five (5) VES were conducted using the Schlumberger configuration and Horizontal spread covering the entire area. The Horizontal Profiling data was carried out to obtain the lateral variation in resistivity. The VES data were interpreted using geophysical software IPI2Win which showed that the area is composed of four layers namely; topsoil, weathered basement, fractured basement and fresh basement. Based on the interpretation of the VES points the depth to basement varies from 10.2 to 63.1m, the thickness of the aquifer varies from 2.34 to 62.2 m and it depths varies from 10.2 to 62.2 m, the resistivity of the overburden (topsoil) varies from 31.3 to 977Ωm, the thickness of the weathered basement varies from 5.21 to 36.7 m. Contour maps were plotted

using the SURFER 10 computer software showing all the topsoil resistivity, aquifer thickness and depth to basement at each VES point. Based on all the data and information the following points VES 01, VES 04 and VES 05 are recommended for suitable groundwater establishment.

REFRENCES

Abaje, I. B., Ati, O. F., & Iguisi, E. O. (2012).Changing Climatic Scenarios and Strategies for Drought Adaptation and Mitigation in the Sudano Sahelian Ecological Zone of Nigeria. In M.A. Iliya & I. M. Dankani (Eds.), Climate Change and Sustainable Development in Nigeria (pp. 99-121). Ibadan: Crown F. Publishers.

Abaje, I. B. (2007). Introduction to Soils and Vegetation. Kafanchan: Personal Touch Productions.

Afuwai G. C. (2013). Understanding the Basis of Electrical Resistivity Geophysical Survey. Lambert Academic Publishing. Germany. Pp 57–64.

Akpaneno, A. F. (2014). Seismic Refraction Investigation of North-Eastern Part of the Federal University of Technology, Minna. *Nigerian Journal of Physics;* (NIP): Special Edition.

Alabi, A.A., Bello. R., Ogungbe. A.S. and Oyerinde. H.O. (2010). Determination of Groundwater Potential in Lagos State University, Ojo; using Geoelectric Methods (Vertical Electrical Sounding and Horizontal Profiling). Report Opinion, 24:68-75.

Anomohanran, O., (2011). Determination of Groundwater Potential in Asaba, Nigeria using Surface Geoelectric Sounding. Int. J. Physical Sci., 6: 7651-7656.

Federal Republic of Nigeria. (2012). Federal Republic of Nigeria 2006 Population and Housing Census. Priority Table Vol 3.Abuja: National Population Commission.

Majumdar, R.K. and Das, D. (2011).Hydrological Characterisation and Estimation of Aquifer Properties from Electrical Sounding Data in Sagar Island Region, South 24 Parganas, West Bengal, India. *Asian Journal of Earth Sciences,* 4(2): 60-74.

Otobo, E. and Ifedili. S.O., (2005). The Vertical Electrical Sounding: A Viable Tool for the Investigation of Fresh Groundwater in the Saline Water Environment with Particular Reference to the Communities along Warri River. J. Nig. Assoc. Math. Phys., 5: 437-442.

Shiklomanov, I. (1993). World Fresh Resources In Water Crisis A Guide to the World Fresh Water Resources Gleick PH (Ed) Oxford University Press, New York.

Telford, W.M, Geldart. L.P and Sheriff. R.E.,(2001). Applied Geophysics 2nd Edition Cambridge University Press, London, New York. (pp 8-12,537 - 540).

Todd, D.K, (2004). Groundwater Hydrology. 2nd Edn., John Wiley and Sons, New York.

Tukur, R., Adamu, G. K., Abdulrahid, I., & Rabi'u, M. (2013). Indigenous Trees Inventory and their multipurpose uses in Dutsin-Ma Area, Katsina State. *European Scientific Journal,* 9(11), 288-300.

Reference to this paper should be made as follows: Akpaneno, A. F., et al. (2017), The Application of Resistivity Method, Vertical Electrical Sounding (VES) for the Location of Good Groundwater Potential at the Female Hostel, Federal University Dutsinma Permanent Site. J. of Physical Science and Innovation, Vol. 9, No. 3, Pp. 44-55.