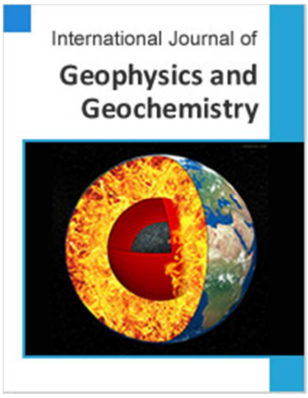
International Journal of Geophysics and Geochemistry
2017; 4(6): 61-65
http://www.aascit.org/journal/ijgg
ISSN: 2381-1099 (Print); ISSN: 2381-1102 (Online)

American Association for Science and Technology



Keywords
Geophysical Investigation, Geoelectric Properties, Hydrogeological Deductions, Vertical Electrical Sounding, Electromagnetic Survey

Received: August 2, 2017
Accepted: October 13, 2017
Published: October 30, 2017

Geophysical Survey Report for Water Borehole at Tudun Wada Bazza, Michika, Adamawa State, Northeast Nigeria

Ayuni Ngo Kilian*, Onudibia Moses Ejike, Fagbenro Waliu Ayoola, Ocheje John Actor

Department of Pure and Applied Physics, Federal University, Wukari, Nigeria

Email address
Oklaayuni@gmail.com (A. N. Kilian), mosesmarke@gmail.com (O. M. Ejike), ayoola@fuwukari.edu.ng (F. W. Ayoola), ocheje@fuwukari.edu.ng (O. J. Actor)
*Corresponding author

Citation
Ayuni Ngo Kilian, Onudibia Moses Ejike, Fagbenro Waliu Ayoola, Ocheje John Actor. Geophysical Survey Report for Water Borehole at Tudun Wada Bazza, Michika, Adamawa State, Northeast Nigeria. *International Journal of Geophysics and Geochemistry.* Vol. 4, No. 6, 2017, pp. 61-65.

Abstract
This report present the results of geophysical investigation carried out at Tudun wada, Bazza, Michika LGA of Adamawa state. The purpose of the investigation is to assess the groundwater potential of the area and to identify a suitable site for the location of a productive motorized borehole. Vertical electrical sounding (VES) and Electromagnetic (EM) methods were used for the investigation; using DDC 2B and ABEM Terrameter respectively. Three EM &VES sounding were carried out. Qualitative analysis reveals H-type of curve where $\rho 1>\rho 2<\rho 3$. Three to four main geoelectric layers were identify from the geoelectric characteristics of the area as unit A with resistivity of 135-380 Ohms-m and an average thickness of 3.5-7.6m, unit B with an average resistivity value of 48-80 Ohms-m with a thickness of 19.6-28.9m, unit C has a resistivity of 105-130 Ohms-m with a corresponding average thickness of 5.4-6.8m while unit D has an average resistivity value of 350-700 Ohms-m representing fresh basement.

1. Introduction

The occurrence of ground water in a basement terrain is hosted within zones of weathering and fracturing (Nur, A and Ayuni, N. K, 2011) which often are not continuous in vertical and lateral extent [Mbiibe, E. Y, 2010]. Most often the occurrence of ground water in a basement complex is confined and localized to weathered/fractured zones [Nur. A and Ayuni, N. K, 2004, Okahue, E. T and Olorunfemi, M. O, 1992, Olayinka, A. I. 1996, Olorunfemi, M. O and Fasuji, S. A, 1993]. Electrical resistivity therefore is often used or preferred because of the resistivity contrast obtained when ground water zone is reached. Sharp lateral changes in the stratigraphic sequence and electrical properties brought about by fractures and fault zones or variable thickness of weathered beds makes interpretation of vertical electrical sounding difficult. Therefore the ability of the layer to conduct electricity and its resistant depends on the type and nature of the materials within the subsurface. Thus most rocks conduct electricity by electrolytic rather than electronic processes. It therefore follows that porosity of rocks is the major control of resistivity of rocks and that resistivities generally increases as porosity decreases. Aloa D. A, et. al 2013 suggested that high hill basement complex rocks [crystalline rocks] reduces the conductivity of groundwater in the adjacent valleys rendering such valleys non aquiferous.

Sequel to the above, a detailed geo-electrical survey using the Electromagnetic [EM] and Vertical Electrical Sounding [VES] was carried out with the intent to determine the geo-electrical parameters [resistivity and thickness] of the subsurface layers and their hydro-geological implications. The two methods adopted are considered more suitable for the subsurface investigation of geologic environments in basement areas.

This report therefore highlights the results of geophysical investigation carried out at Tudun Wada Bazza. Tudun Wada is one among the three communities that comprises Bazza community. It is located about 3km North of Bazza town and Michika town figure 1. It has a population of over 5000 people [as extrapolated from the 1999 population census].

The topography of the area is rugged and its vegetation consists of sparsely deciduous trees and grasses.

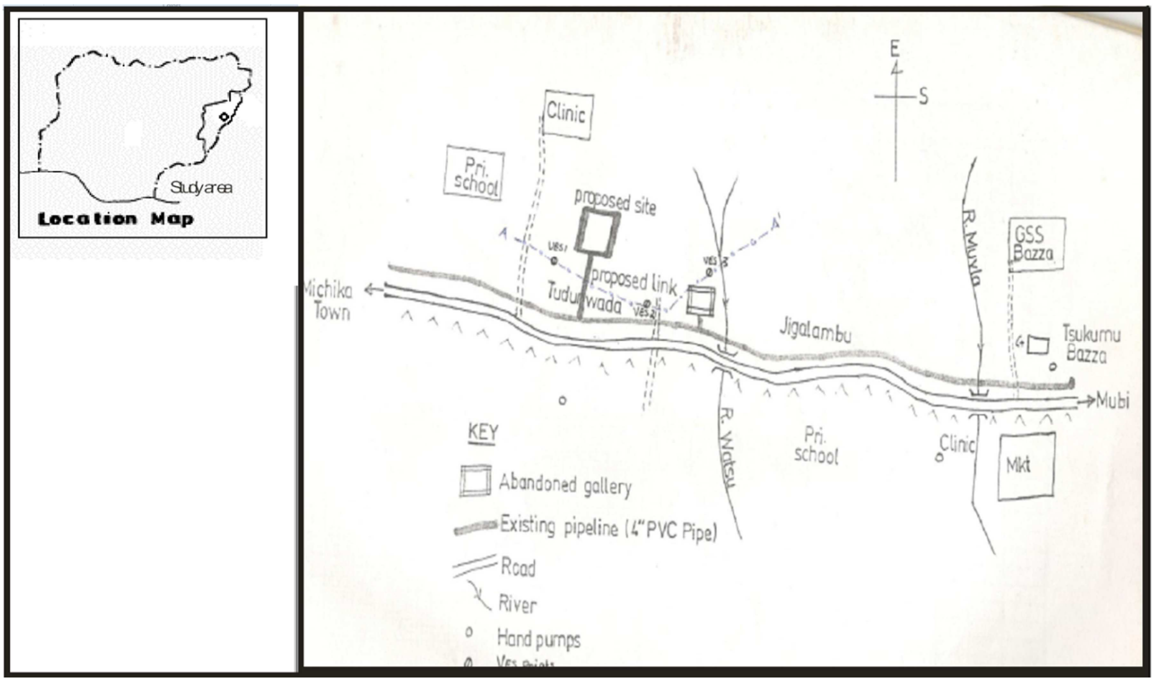


Figure 1. *Location map showing existing hand pumps and VES points.*

2. Geology and Hydrogeology of the Study Area

Tudun Wada, Bazza is situated on the Pre-Cambrian Paleozoic crystalline basement complex rocks of north eastern Nigeria comprising of granites [Carter et al, 1963]. The granitic rocks in this area have undergone weathering leading to unconsolidated overburden consisting of sands, clays and laterite.

The hill in the vicinity appears to be composed of biotite granite [Nur, A and Ayuni N. K 2011]. Minor pegmatite and dolerite dykes also exist in the bedrock area surrounding the hills. The crystalline basement rocks are overlain by weathered profile of variable thickness, [Nur and Ayuni 2004, Bassey et al, 2012]. The weathering profile is likely to be gradational from fresh unfractured bedrock at the base through a fracture zone which is usually less than 8m thick, an increasingly altered zone with increasing clay content upward and thin loose soil at the surface. A thick alluvium deposit have been detected along the bank of the river Wantse and varies from 12.5m to 19.6m.

According to Carter et. al 1963, the Basement complex of northeast Nigeria is divided into Mandara Mountain, Alantika Mountain, Shebshi Mountain, and the Adamawa Massifs.

3. Data Collection and Interpretation

Two geophysical methods, Electromagnetic and Vertical electrical sounding methods were employed using DDC-2B and ABEM Terrameter respectively.

The measurements were taken along profile AA[1] figure 1 above within the town at stations intervals of 10m.

Electromagnetic fields were generated by passing alternating current through a small coil made up of many turns of wire through a large loop of wire. The response of the ground is the generation of secondary electromagnetic fields and the resultant fields are detected by the alternating currents that they induce to flow in a receiver coil by the process of electromagnetic induction. The depth of penetration of an electromagnetic field depends upon its frequency and the electrical conductivity of the medium through which it is propagated. Electromagnetic fields are attenuated during their passage through the ground, their amplitude decreasing exponentially with depth.

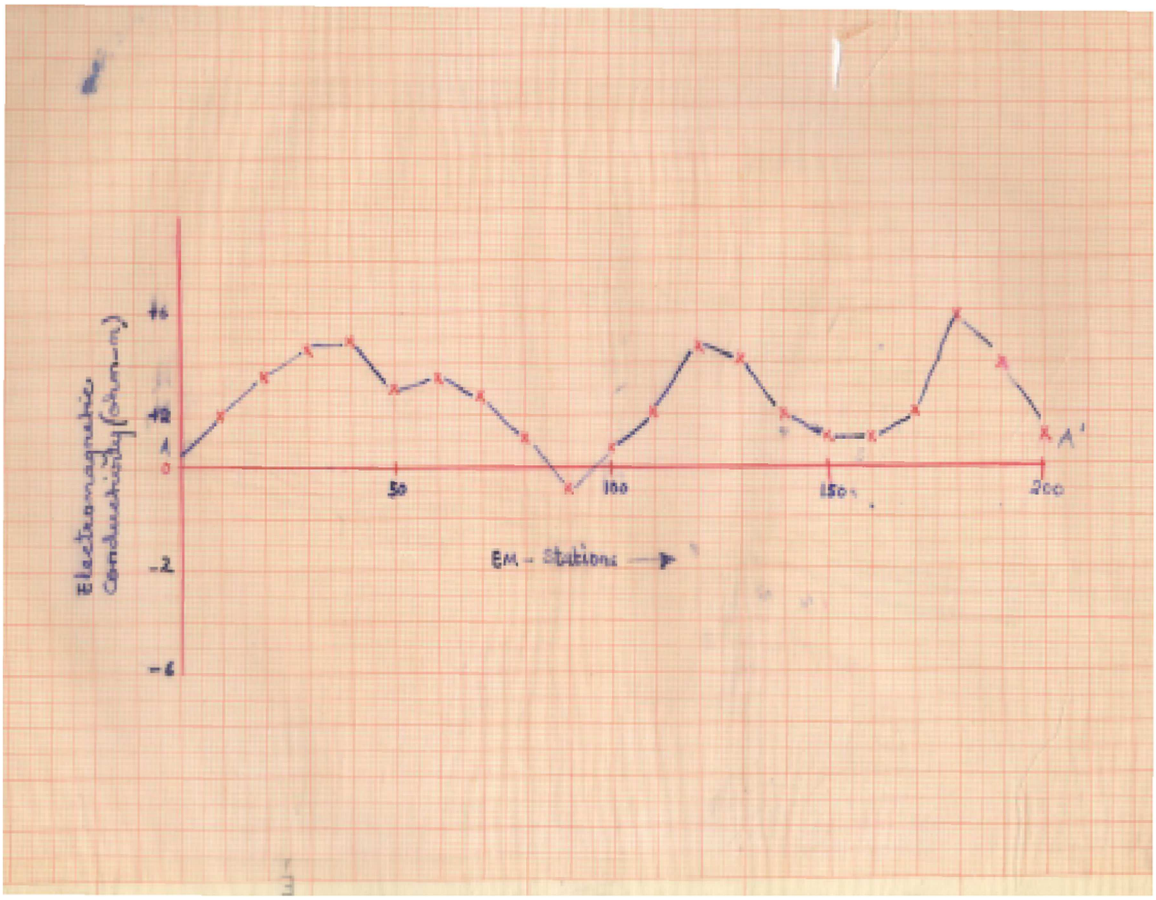


Figure 2. *Electromagnetic Profile along AA¹.*

The EM conductivity survey was used to identify points for further probing, see figure 2 above. The soundings were employed for depth probing. Full Schlumberger electrode configuration [AB =5MN] was used with maximum electrode spread of 100m. The data obtained from the EM measurement were computed and the profile plotted see figure 2 above.

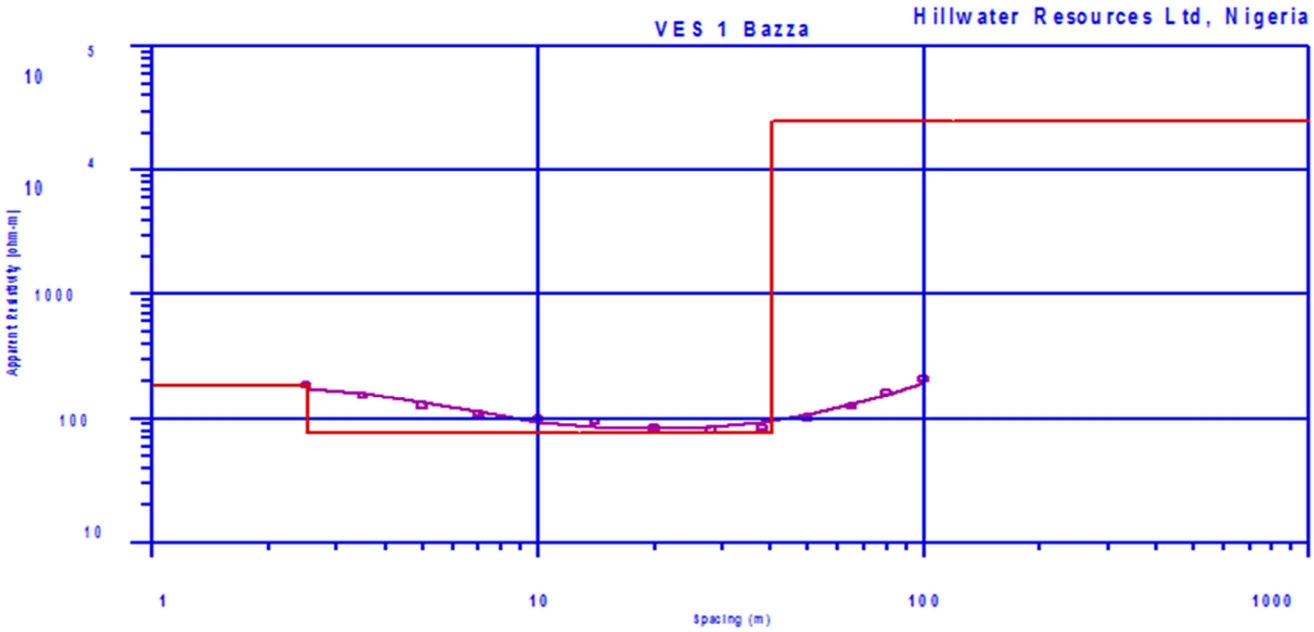


Figure 3. *Sounding Curve/Earth model obtained from VES 1 & 2.*

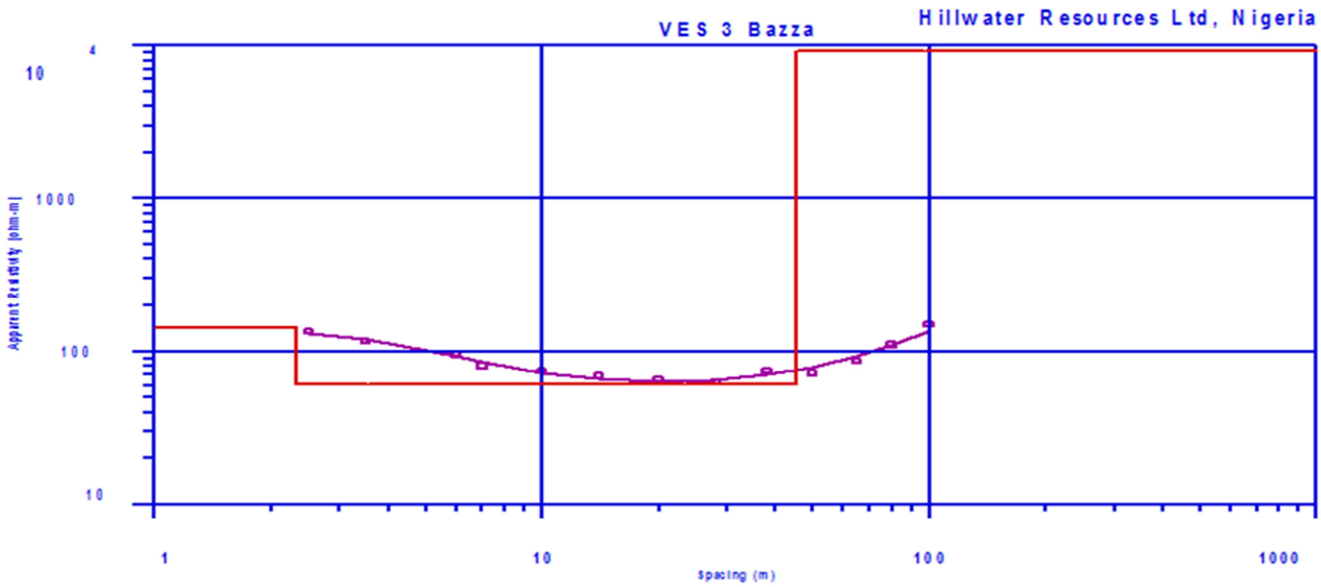


Figure 4. *Sounding Curve/Earth model obtained from VES 3.*

The obtained profile shows the lateral variation in the horizontal conductivity of the subsurface formation. Generally high conductivity zones are of interest in groundwater exploration. Such zones were identified and mark for vertical electrical soundings. Three Schlumberger vertical electrical sounding were carried out. The VES data obtained were plotted on bilogarithmic paper and interpreted using partial curve matching technique with two master curves and auxillary point charts Mooney & Wetzel [1956]. The obtained geoelectric models were used as starting points for computer modeling to obtain the best fit models [number of layers, resistivity, and thickness of each layer] for the field curves figure 3 & 4 above.

The computer programmed [Schlumberger Sounding Data Processing Survey] used is based on a concept presented by Denver & Co, [1990]. The purpose of which is to compute a layered earth model whose theoretical apparent resistivity curves agrees as closely with as possible [in square sense] with the field curve. The parameters and mathematical formulae used for this study are readily found in [Mbonu et. al, 1991]. According to Srinivasan et. al, 2013, the main objective of quantitative interpretation of VES curves is to obtain the geoelectrical parameters ie the geoelectrical layer which is called by its fundamental characteristics, resistivity 'ρ' and thickness 'h'.

4. Discussion of Results

4.1. Geo-electric Properties

The obtained results were used to infer lithological sequence anticipated to be penetrated while drilling at each of the VES points. Three to four main geoelectric layers were identified. The upper most layers, unit A has a thickness ranging between 3.5-7.6m and a resistivity which varies between 135-380ohms-m. The first layer overlain unit B with thickness of 19.6-28.9m and a resistivity in the range of 48-80 ohms-m. Unit C with a thickness of 5.4-6.8m and a resistivity between 105-130 Ohms-m underlies unit B. Unit D whose thickness could not be determined and has a resistivity in the range of 300-700ohms-m underlies unit C Table 1

Table 1. *Resistivity and average thickness of layers in the study area.*

Layer	Resistivity	Average Thickness	Description
Unit A	135 - 380Ωm	3.5 - 7.6m	Top Lateritic soil.
Unit B	48 - 80Ωm	19.6 - 28.9m	Weathered and fractured basement
Unit C	105 - 130Ωm	5.4 - 6.8m	Fracture basement
Unit D	350 - 700Ωm	00	Fresh basement

4.2. Hydrogeological Deductions

Unit A is a superficial layer of topsoil and highly weathered rocks. Unit B is a layer of weathered and fractured basement complex rocks. The last layer whose thickness could not be determined is considered to be the fresh basement complex rocks at VES 1& 2 respectively figure: 3 & 4.

However, at VES 3, the second layer unit B is a layer of thick alluvium deposits while the third layer is considered to be a layer of partially fractured basement rock.

At site like all other basement complex rocks area favorable conditions for accumulation of groundwater include thick layer of alluvium to weathered and fractured bedrock. The groundwater potential of an area can therefore be inferred from its resistivity. The second layer unit B that is expected to contain some alluvium deposits and weathered to fractured basement complex rock is considered to be the aquiferous layer in the area. To that respect, maximum thickness of these layers is required for maximum groundwater exploitation.

5. Conclusion

The geophysical investigation established three to four main lithological units in the area and identifies the second layer and third layer of VES 3 as the main water bearing aquifer. The survey also revealed that within the surveyed points VES 3 has the highest water bearing potentials and is consequently being recommended for the sighting of the motorize borehole. The study also established that the area has good groundwater potential especially VES 3 of the area under investigation which correspond to the aim of this study.

Recommendation

A minimum drilling depth of 45-60m is recommended for the borehole to ensure that the groundwater

Potentials of the point are fully exploited. A careful and accurate geologic logging of the borehole should be undertaken during the drilling work to ensure that the aquifer is accurately identified and properly screen.

References

[1] Aloa D. A, Amadi A. N, Adeoye Yinka and Oladipo A. V 2013: Geo-Electrical and 3D Imaging of Groundwater Distribution along Flood Planes of River Niger at Jebba, North Central Nigeria. Enviromental and Natural Research, vol 3. No. 2. Pp 61-68.

[2] Carter, O. J, Baber W & Tait, E. A, 2012: The Geology of part of Adamawa, Bauchi and Borno Provinces, NE Nigeria. Geol. Survey Bulletin No. 30.

[3] Mbiimbe, E. Y, Samaila, N. K, and Akanni, D. K, 2010: Groundwater Exploration In Basement Terrain Using Electrical Resistivity Sounding (A case study of Rimin Gado Town and Evirons, Kano State), North Central Nigeria. Continental Journal of Earth Science, Vol 5. No. 1, pp 56-63.

[4] Srinivasan K, Poongothai S and Chidamambaram S 2013: Identification of groundwater Potential zone by using GIS and Electrical Resistivity Techniques in and around Wellington Reservoir, Cuddalore District, Tamilnadu, India. European Scientific Journal, vol. 9. No 17.

[5] Moooey & Wetzel, 1956: Master Resistivity Curves for a two, three and four layer Earth. University of Minnesota.

[6] Nsikak, E. Bassey, E. F. C. Dike & Othniel, K. Likkason, 2012: Digital Filtering of Aeromagnetic Maps for Lineaments Detection in Hawal Basement Complex of Hawal Area. NE Nigeria. Journal of Mining and Geology Vol. 40 (1), pp 1-11.

[7] Nur. A and Ayuni, N. K, 2004: Hydrogeo-electrical study of Jalingo Metropolis and its Environs, Northeast Nigeria, Global Journal, of Geological Science. Vol 2, No. 1, Pp 101-109.

[8] Nur. A and Ayuni, N. K, 2011: Hydro—geophysical study of Michika and Environs Northeast Nigeria, International Jour. Of physical Sciences. Vol 6 (34), pp 7816-7827.

[9] Okahu, E. T and Olorunfemi, M. O, 1992: Hydro-geophysical and geologic significa nce of geo-electric survey at Ile-Ife, Nigeria. Jour. Of Mining and Geology. Vol 28, No 1, pp 221-229.

[10] Olayinka, A. I, 1996: Non uniqueness in the interpretation of bedrock resistivity fro m sounding curves and hydrological implication. Jour, of Nig. Association of Hydrogeologists 7 (1&2) pp 49-55.

[11] Olorunfemi, M. O, and Fasuji, S. A 1993: Aquifer types and geo-electric/hydrologic, with characteristics of part of the Central Basement terrain of Nigeria (Niger State). Journal of African Earth Science 16. Pp 317-403.