International Journal of Science and Advanced Innovative Research
ISSN: 2536-7315 (Print) 2536-7323 (Online)
Volume 3, Number 2, June 2018
http://www.casirmediapublishing.com

INVESTIGATION OF SUBSURFACE LITHOLOGY AND AQUIFER POTENTIALS IN AKWA IBOM STATE POLYTECHNIC CAMPUS, IKOT OSURUA, AKWA IBOM STATE, NIGERIA USING ELECTRICAL RESISTIVITY METHOD

[1]Inyang, Udeme Udofia, [2]Igboekwe, M. U. & [2]Akpan, O. P*
[1]Department of Science TechnologyMicheal Okpara University of Agriculture, Umunike
[2]Department of Science Technology, Akwa Ibom State Polytechnic, Ikot Osurua
Email: apostleop5family@yahoo.com
Corresponding author*

ABSTRACT

The study was carried out to investigate the aquifer potentials and subsurface lithology in Akwa Ibom State Polytechnic Campus, Ikot Osurua, Ikot Ekpene, Akwa Ibom State. The study area lies between latitude 5°09′ and 5°40′N and longitude 7°18′ and 7°20′E, it is underlaid by sedimentary formation of late tertiary and holocence ages. A total of five (5) vertical electrical sounding (VES) were conducted using the integrated Geo-instrument service (IGIS) resistivity meter to generate the field data. The Schlumberger sounding was carried out with current electrode spacing (AB) ranging from 1-300m. The distance used for the potential electrode spacing (MN) ranging from 0.25-10m. This array was employed in view of it resolution power and its reliability. The field data obtained were subjected to interpretation by partial curve matching and by computer iteration using IP12 WIN software. The interpreted results were constrained by lithologic log to produce the geoelectric sections of the subsurface. The geoelectric section showed three (3) to four (4) layered subsurface of top soil, lateritic sand, consolidated sand, clay sand and aquifer layer with different curve types which were Q, KA, K and KK Aquifer characterization of the area showed that the aquifer resistivity with depth ranging from 89.2Ωm to 3287Ωm and 50m to 100m although it varies in some locations, this is an indication of the presence of fresh groundwater.

Keywords: *Groundwater potentials, subsurface lithology, vertical electrical sounding (VES), Schlumberger configuration.*

INTRODUCTION

The availability and accessibility of quality and portable water resource is one of the major concerns in developed, developing and underdeveloped societies all over the world. Groundwater is described as the water found beneath the surface of the earth in underground streams and aquifer (Anomohanran, 2011). It is a replenishable resource and has several advantages over surface water (Aswathanarayana, 2001, Steinich & Marín, 1996). Water is one of the essential natural resource for the existence of life on Earth. Fresh and clean water is of fundamental importance to the survival, protection and development of human needs as well as for the conservation of the environment. As a result the demand for fresh water has increased significantly throughout the world due to the population growth, climatic change and socioeconomic development. In this area, it is therefore important to ascertain whether the aquifer is prone to contamination or not. To achieve this, geophysical and hydrogeological studies are necessary in the study area. Electrical resistivity methods are effectively used for groundwater exploration in areas where good electrical resistivity contrast exists between the water bearing formation and the underlying rocks. The method enables the determination of subsurface resistivity by sending an electric current into the ground and measuring the electrical potential produced by the current. A planned geo-electrical investigation is capable of mapping an aquifer system, clay layers, the depth and thickness of aquifers and qualitatively estimating local groundwater flow (Steinich & Marins, 1996, Israil *et al; 2006)*

The present study was carried out to investigate the Aquifer potential and subsurface lithology in Akwa Ibom State polytechnic campus, Ikot Osurua in Ikot Ekpene Local Government Area, Akwa Ibom State.

LOCATION AND GEOLOGY OF THE STUDY AREA

The study area is in the Niger Delta, located in the southern part of Nigeria between latitude 5° 09´and 5° 40′ N and longitude 7° 18´ and 7 °20´E. (Figure1). The geology of the Niger Delta has been extensively described by several authors including Etu- Efetobor and Akpokodje (1990), Short and Stauble, (1967). It is underlain by sedimentary formation and it belongs to the area classified as coastal plain sand which is known as the Benin formation. And the Benin formation is composed of loosely consolidates sand and gravel with intercalation of shales. During dry season, the water level in rivers and streams decreases suggesting that part of the river is recharging the aquifer beside precipitation. On the north-west and north-east, the area is bounded by cretaceous to tertiary sediments. The temperature is uniform throughout the year. On the other hand, the high permeability of Benin formation, the overlying lateritic earth and weathered top of this formation as well as the underlying clay shale provide the hydrogeological condition favoring the aquifer formation in the area. The objective of the study is to delineate the aquifer potentials and subsurface lithology in Akwa Ibom State Polytechnic Campus Ikot Osurua with the aim of giving a guide to sitting high yield boreholes in the area.

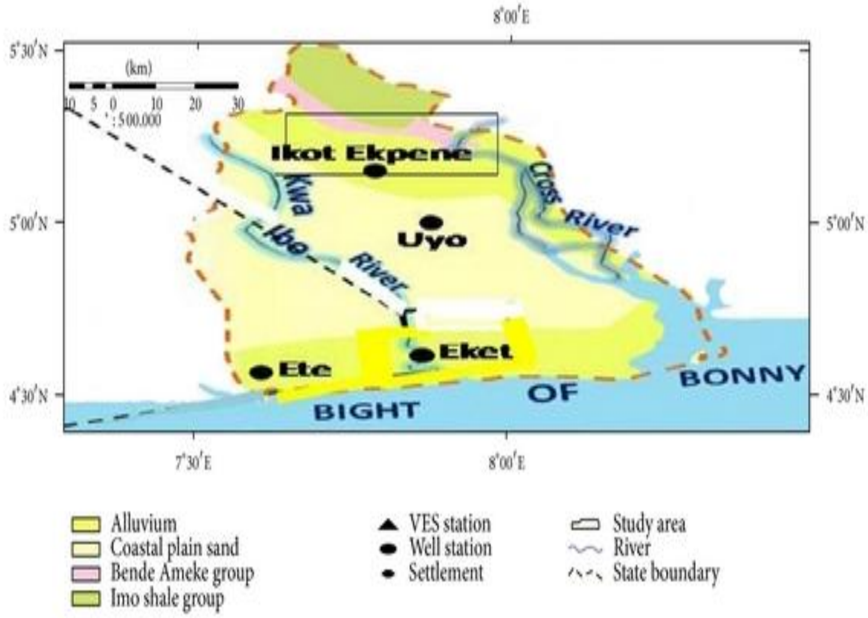

Figure 1: Map of Akwa Ibom State showing the location and the geology of the study area

MATERIALS AND METHOD

The survey procedure adopted for field acquisition is the vertical electrical sounding (VES) technique. The VES technique measures vertical variation in ground resistivity with depth. In this method, series of resistances were acquired at successively larger electrode spacing while maintaining a fixed central reference point. For this study, the Schlumberger configuration was used to acquire VES data at five (5) points in the school community. The current electrode separation (AB/2) varied from 1m to 300m at some stations. Current electrodes were passed into the ground through the current electrodes planted on the ground while the resulting potential was picked by the potential electrodes. Measurements were taken along profiles. The potential electrode separation ranged from 0.25m to 10m, while current electrode separation ranged from 1m which was progressively expanded along a straight line of profile up to 300m on both sides at some point. The apparent resistivity values were ascertained by multiplying the resistance gotten from the resistivity meter with an appropriate geometric factor which depends on the current and potential electrode spacing (Teldford et al, (1990) as shown in equation 1 below.

$$\rho_a = K \frac{\Delta V}{I} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where;

K represents the geometric factor of the Schlumberger electrode array which is given by the equation:

$$K = \pi \left(\left(\frac{AB}{2} \right)^2 - \left(\frac{MN}{2} \right)^2 \right) \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where;

ρ_a = Apparent resistivity

AB= Current electrode spacing

MN= Potential electrode spacing

$\pi = 3.142$

The Schlumberger electrode array was employed due to its simplicity, being faster and required fewer number of field workers.

RESULT AND DISCUSSION

The summarized results of the interpretation of the field report is presented as shown in table1.The measured resistances were converted to apparent resistivity by multiplying with their respective geometrical factors. This apparent resistivity was plotted against half current electrode spacing (AB/2) on a bi-logarithmic graph using Microsoft excels to generate curves from the field data. Unwanted values that failed to follow the dominant curve trend were expunged by the process of curve smothering .The maxima and minima on the smoothened VES curves were taken to depict the vertical variation in resistivity with depth. These resistivity values were further subjected to computer modeling using the inversion technique. This was made possible by geographical software called IP12WIN which involves a forward or inverse modeling approach to generate a computer modeled curve which shows the measured apparent resistivity pseudo section, calculated apparent resistivity pseudo section and inverse model resistivity section. Due to the geological nature of the study area being sedimentary area, there are resistivity values that shows the structure of the study area which are in layers. The layer parameters: resistivity, depth and thickness for each (VES) point were obtained after a series of iteration to match the field curve with theoretical curves. From the modeled VES data, it was observed that out of the five (5) VES points, four have three layers; one have four layers with Q, KA, K and KK curves type dominating (Figures 2-6).

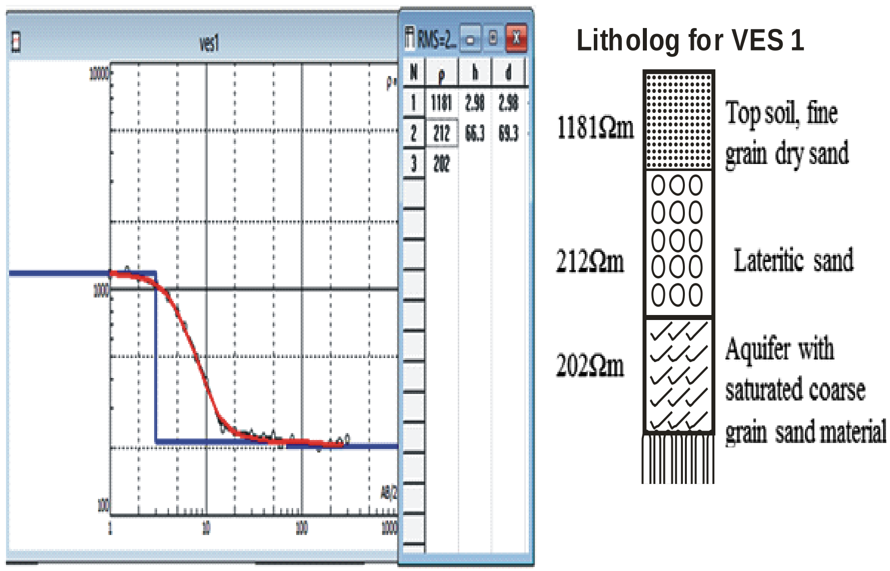

Figure: 2: Model layer curve for VES 1

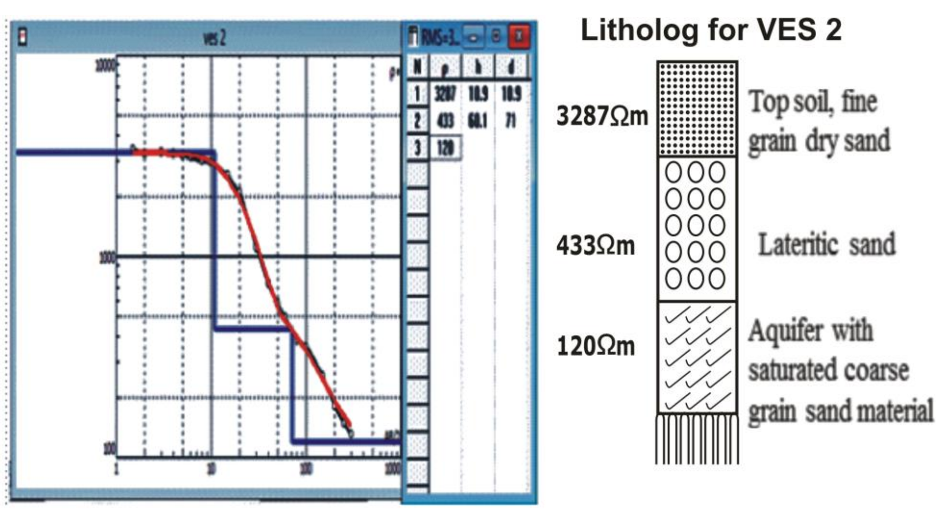

Figure: 3: Model layer curve for VES 2

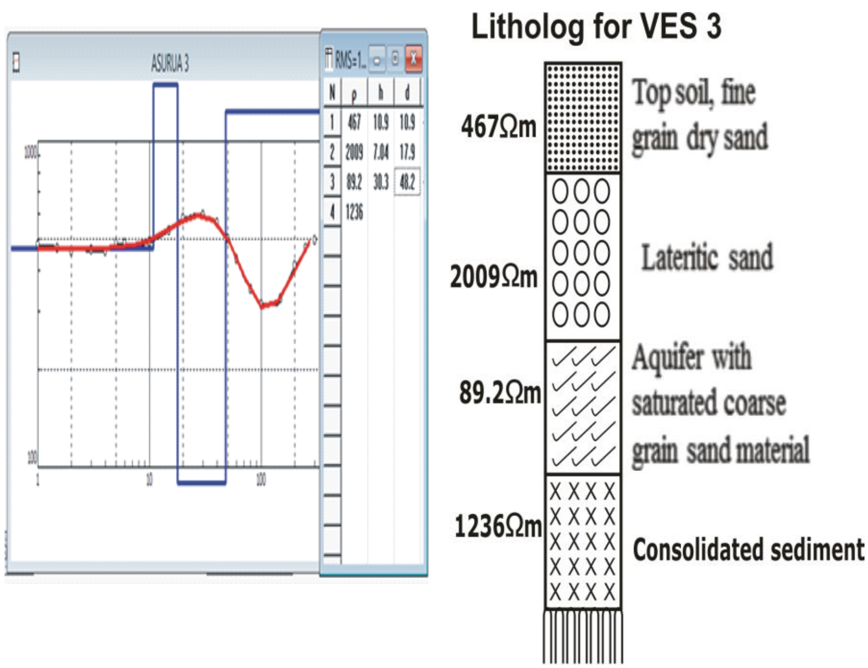

Figure: 4 Model layer curve for VES 3

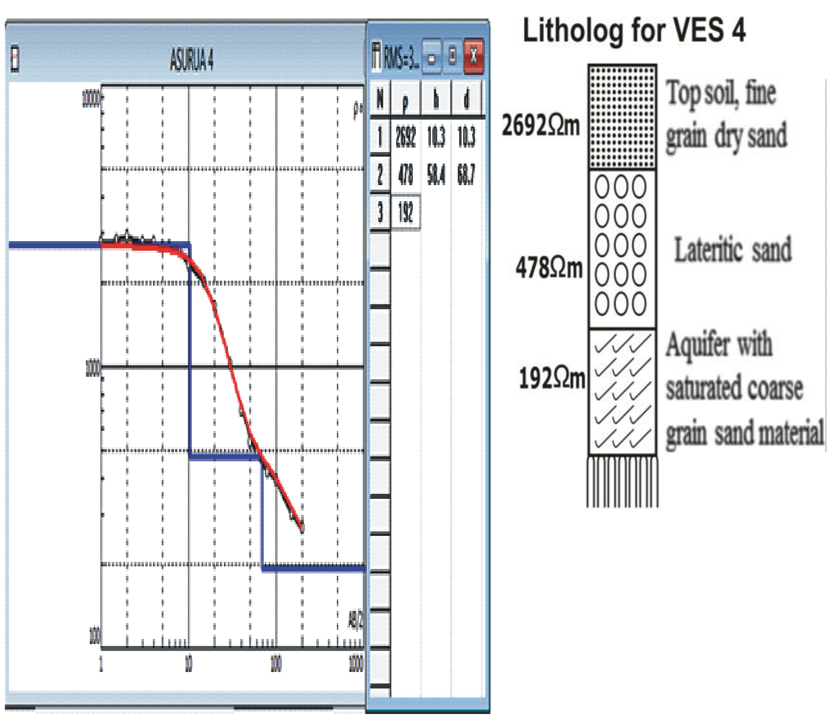

Figure: 5: Model layer curve for VES 4

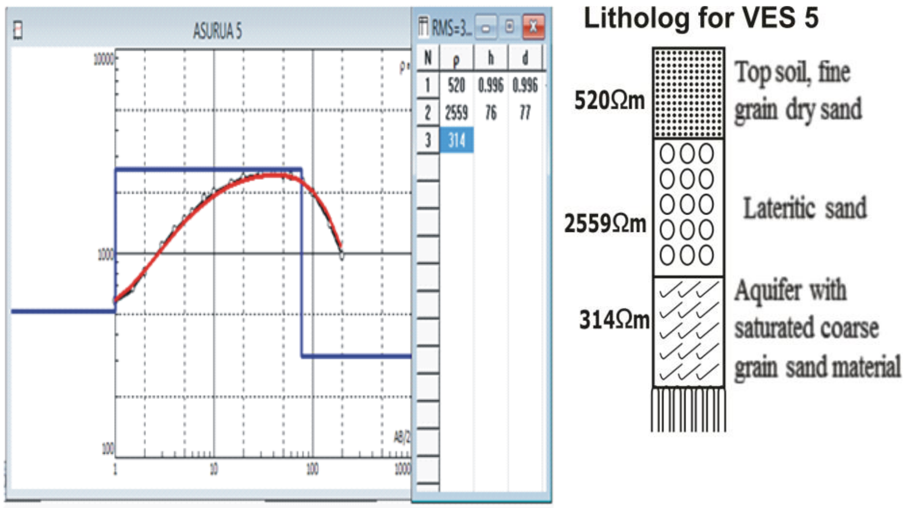

Figure: 6: Model layer curve for VES 5

For the three layer curves (Figures 2,3,5 & 6), the estimated layer depth to bottom varies from 0.99m to mean of 75.1m for the first layer, 68.7m to mean of 75.1m for the second layer and the depth of the third layer could not be determined from our data. The mean resistivity varies from 520Ωm to 3287Ωm for the first layer, 212Ωm to mean resistivity of 2559Ωm for the second layer and 120Ωm to means resistivity of 314Ωm for the third layer. Fine grain dry sand material dominating the first layer although it varies in some station, where the topsoil is loamy sand, while the main lithological composition of the second layer is coarse lateritic sand materials and the third layer is mainly dominated by the aquifer with saturated coarse grain sand material. For the four layer curves (Figure 4), the depth to bottom is 18.9m for the first layer, 7.84m for the second layer and the depth of 38.9m for the third layer, the fourth layer could not be determined from our data. Also the mean resistivity value ranges from a minimum of 467Ωm for the first layer, 2009Ωm for the second layer, 89.2Ωm for the third layer and 1236Ωm for the fourth layer. The formation is composed of fine grain dry sand, coarse lateritic sand materials, aquifer with saturated coarse grain sand material and consolidated sediment. In genera table1 above revealed the existence of three to four geoelectric layers in the study area. Hence since the resistivity of a rock material is a function of soil moisture and generally decreases with increasing water content, it follows that the degree of water content, and its salinity, interconnectivity of the pores in rocks which defines it's permeability, degree of compaction and orientation during deposition, texture, temperature at any depth and porosity affect the resistivity of rock. Furthermore the mean resistivity of the third layer is far lower than the resistivity of the first, second and fourth layer. Therefore, the resistivity ranges between 89.2Ωm to approximately 314Ωm is an indication of the presence of fresh ground water in the third layer. The fourth layer is consolidated material which serves as both blockade and protective layer for the aquifer.

CONCLUSION

Aquifer characterization of the survey area showed the resistivity which ranged from 89.2Ωm to 3287Ωm and aquifer depth of 50m to 100m although it varies in some location. From the result, it is therefore recommended that boreholes for sustainable water supply in Akwa Ibom State Polytechnic community should be drilled to about 50m to 100m; this is an indication of the presence of fresh groundwater. Hence, it could be recommended that borehole in this study area should be drilled to the depth of 50m to 100m to enable tapping clean and uncontaminated ground water. Also, geophysical and geological information should be the guideline for drilling of boreholes across the polytechnic community

REFERENCES

Aswathanarayana, U. (2011). *Water Resources Management and the Environment.* A. A. Balkema, Lisse, The Netherlands.

Anomohanran, O. (2011): Determination of Groundwater Potential in Asaba Nigeria using Surface Geoelectric Sounding, International Journal of the Physical Sciences, 6(33): 7651-7656.

Etu- Efeotor, J O; Akpokodje, E G (1990): Aquifer Systems of the Niger Delta. Nigerian Journal of Mining Geology Vol 26 (2) pp 279-284.

Israil, M., Mufid al-Hadithi and Singhal, D.C. (2006). *Application of a Resistivity Survey and Geographical Information System (GIS) Analysis for Hydrogeological Zoning of a Piedmont Area, Himalayan Foothill Region, India.* Hydrogeology Journal, 14: 753–759.

Steinich, B. and Marín, L.E. (1996). *Hydrogeological Investigations in North-Western Yucatan, Mexico, using Resistivity Survey. Ground water, 34(4): 640-646.*

Telford W.M, Geldart, L. P. and Sheriff, R. E. (1990), *Applied*

Geophysics, Second Edition, Cambridge University Press,

Short, K C; Stauble, A J (1967): Outline of Geology of Niger Delta. American Association of Petroleum Geologist Vol. 51 No 5 pp. 761-779.

Table 1 Summarized results of data interpretation for the 5 (VES) point

VES No	No. Of Layers	P^1 H_1	P^2 H_2	P^3 H_3	P^4 H_4	P^5 H_5	Total thickness (m)	d_1	d_2	d_3	d4	Curve type	% error
1	3	1181 2.98	212 66.3	202			69.3	2.98	69.3			Q	2.1
2	3	3287 10.9	433 60.1	120			71.0	10.9	71			Q	3.5
3	4	467 7.04	209 10.9	89.2 30.3	1236		48.2	10.9	17.9	48.2		KH	1.6
4	3	2692 10.3	478 58.4	192			68.7	10.3	68.7			Q	3.0
5	3	520 6.99	2559 76	314			82.9	0.99	77			K	3.2