Geoelectrical and Hydrochemical Assessment of Groundwater Potential in Tantua-Ammassoma, Bayelsa State, Nigeria

[1]Bunonyo, T. Y., [1]Adanya, J. G. and [2]Marere, O.

[1]Department of Physics, Niger Delta University, Bayelsa State.
[2]School of Marine Technology, Burutu, Delta State.
Corresponding Author's: tbunonyo@gmail.com

Abstract

Geophysical and hydro-chemical investigations were carried out in parts of Tantua-Amassoma within Bayelsa State of Nigeria. The investigations were aimed at ascertaining sites where bore-holes will produce potable water. The SAS 1000 ABEM Terrameter model was used as to acquire geo-electrical resistivity which were analyzed and geo-electrically modelled using IPI2WIN soft-ware. the field data and the IPI2WIN software was used to provide the model parameter for each VES point. Trace element content (Pb, Cu, Zn. Fe. Mn and Co) were determined using Atomic Absorption Spectrometer (AAS). Top layer resistivity ranges from 0.529 – 535 Ωm. Top layer resistivity values less than 10 Ωm probably represent clayey sand with saline water, top layer with resistivity value about 500 probably represent clayey sand. From the result obtained; Vertical var-ying succession of high and low resistive geoelectric layer which indicates sandy formation with intercalation of clay bodies; High Cobalt (Co) concentration of 0.35925mg/l for sample 2, predict-ing harmfulness of the water when compared to World Health Organization (W.H.O) allowable permissible limit standard, from Defense Industries Corporation chemical laboratory in Kaduna. The work suggested further studies and research work that can lead to sustainable exploitation/use and management of groundwater resources in study location.
KEYWORDS: Aquifer, Geoelectric, Data, Groundwater

INTRODUCTION

Water is vital for all living organisms to survive, and for the functioning of ecosystems, communities, and economies worldwide. In the absence of water, the socio-economic life of man cannot be thoroughgoing; hence, man has always put in effort to make sure clean water is at his reach. Efforts at enhancing efficient public water supply is never complete until every citizen or inhabitants of a particular place have unhindered access to potable and safe water. It is essential and indispensable for all human activity and for all forms of life (María *et. al.,* 2014). Groundwater is an essential resource in the urban and rural areas of Nigeria. It is accessed mainly in the form of shallow (hand-dug) and deep (boreholes) wells. Water is one of the basic needs of life, as the population grows and expands; the need for water equally increases (Bunonyo et al., 2018). Assessment of ground-water quality requires determination of ion concentrations which decide the suitability for drinking, agricultural and industrial uses. Some heavy metals are very essential in human health, but they may cause various health problems, if present in higher concentrations (Tiwari et al., 2013). Groundwater contamination resulting from leaching of decomposed waste, septic tanks, pesticide, etc., has caused

some boreholes/wells to be abandoned (Makeig, 1982). Tantua is in Bayelsa State, Nigeria (lies between latitude 04^0 58 and 04^0 97 N to longitude 006^0 06' and 00 08 E), located within the coastal plain sands which constitute the regional aquifer, is highly elongated and contain irregular lenses of aquitard (Ekine and Osobonye, 1996).

MATERIALS AND METHODS

For the geophysical method, the ABEM - Signals Average System (SAS 1000) Terrameter was used for acquiring the field data, whereby consecutive readings were taken with the electrodes; current C1 and C2, and potential (P1 and P2) driven into the ground and connected to a cable from which current flows to the Terrameter and readings are taken. The technique used in the data acquisition was the Schlumberger array method; where AB>5MN, as the system is moved along a traverse. A total of four vertical electric sounding (VES) points was carried out with spread length of 200m covered for each station in the study area. The raw data was calculated and analysed digitally using 1PI2WIN software; to get the corrected resistivity values and R.M.S errors. The apparent resistivity values are obtained by increasing the electrode spacing about a fixed point are plotted in a log-to-log scale against half the electrode spacing (AB/2) to get a few resistivity curves.

For the hydro-chemical analysis, water samples were collected into bottle container from an existing close by borehole for analysis in the laboratory, using the Atomic Absorption Spectrometer (AAS) machine to identify trace metals like Zn, Ni, Mn, Pb, Fe, Cu, and Cd. To prevent contamination, all sampling materials and containers were sterilized. Samples were also properly labelled before taken to the laboratory.

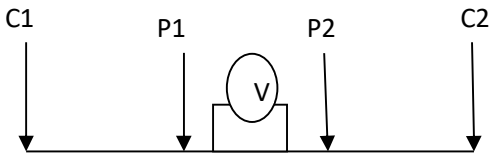

Figure.1: Schematic diagram showing Schlumberger array

From the fig.1 which described the geoelectric Schlumberger array using the Ohm's law principal of operation of current, potential and resistance relationship to geometric factor K result to the apparent resistivity (Killer and Frischnecht, 1966).

$$I=V/R \qquad 1$$

$$\rho_a= RK \qquad 2$$

$$\rho_a= (V/I)\, K \qquad 3$$

RESULTS AND DISCUSSION

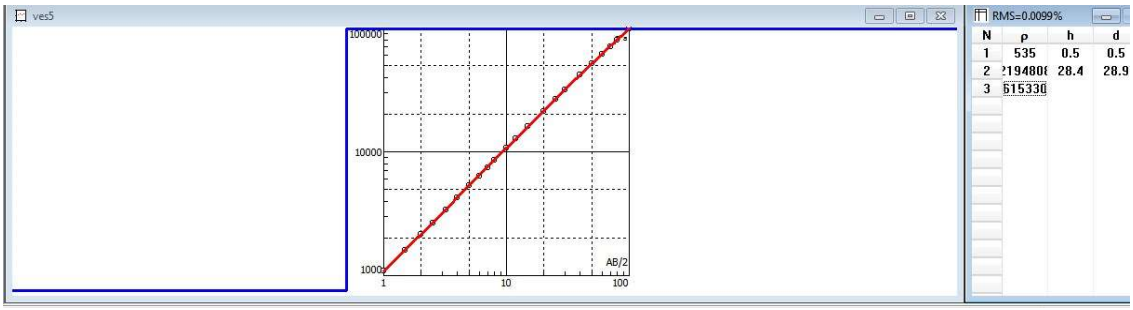

Figure 2: VES 1 of Tantua Amassoma Town

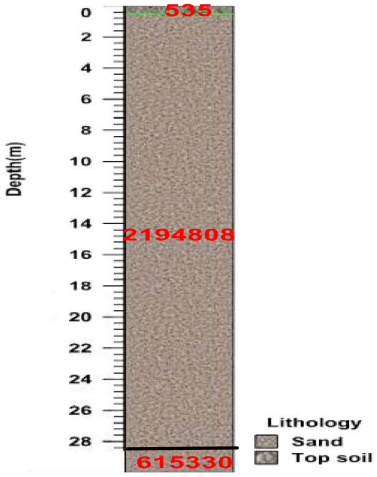

Figure 3: Lithology of VES 1

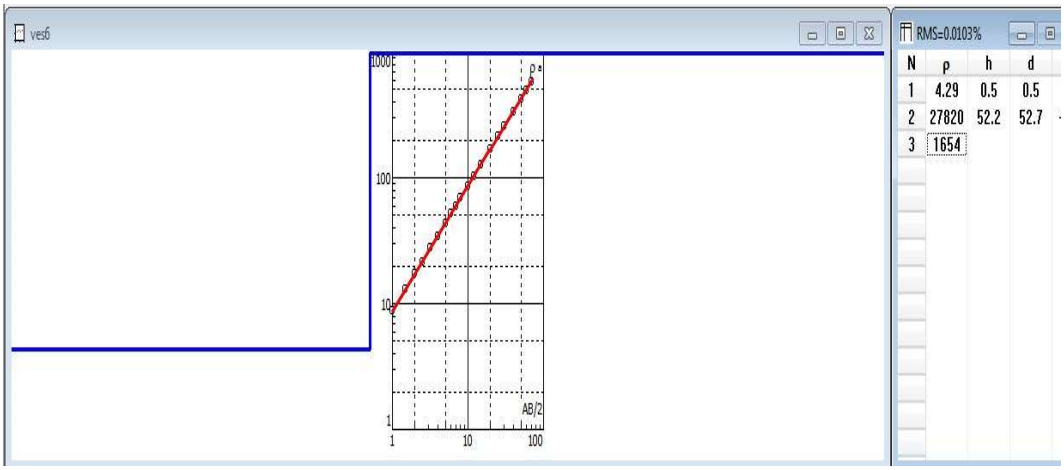

Figure 4: VES 2 Tantua Amassomma town

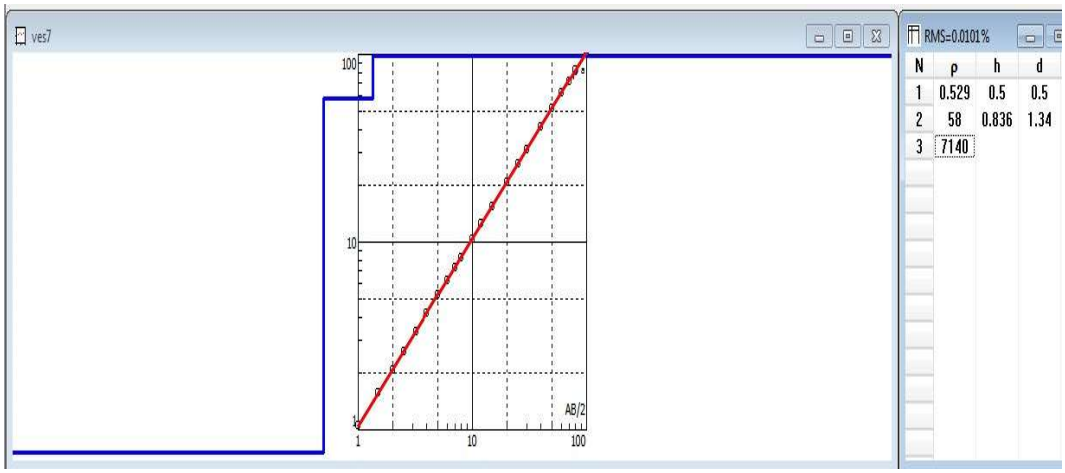

Figure 5; VES 3 of NDDC Road Ammassoma Town

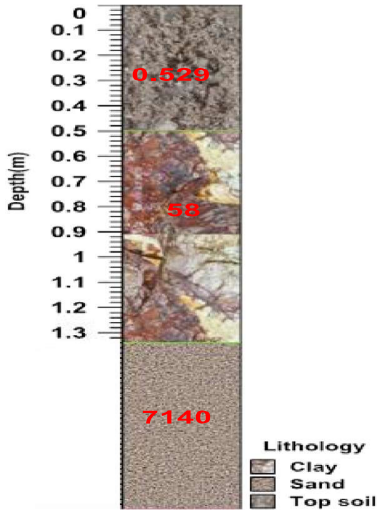

Figure 6: Lithology of VES 3

Table 1: VES INTERPRETATION RESULT TABLE

VES	GEOELECTRIC LAYER	RESISTIVITY (Ωm)	TOP DEPTH (m)	INFERRED LITHOLOGY	REMARKS
1	1	535	0	Topsoil	Geoelectric layer 2 and 3 devoid of water and the sand fining downward.
	2	2194508	0.5	Sand	
	3	615330	28.9	Sand	
2	1	4.29	0	Topsoil	Layers 2 and 3 are probably moisture zone and fresh water saturated zone
	2	27820	0.5	Sand	
	3	1654	52.7	Sand	
3	1	0.529	0	Topsoil	Layer 3 Not well saturated or probably dry or very coarse.
	2	58	0.5	Clay	
	3	7140	1.34	Sand	

TABLE 2: DESCRIPTIVE OF HEAVY METALS IN THE STUDY AREA (TANTUA - AMASSOMA)

METALS	SAMPLE 1 CONCENTRATION (ppm)	SAMPLE 2 CONCENTRATION (ppm)	WHO LIMIT ON ACTUAL CONCENTRATION (ppm)
Zinc (Zn)	-0.9289	-0.9385	3.0mg/l
Nickel (Ni)	-0.0719	-0.0729	0.02mg/l
Manganese (Mn)	-1.7683	-1.9054	0.1mg/l
Lead (Pb)	-0.3505	-0.3085	1.00mg/l
Iron (Fe)	-0.1938	-0.1277	1.00mg/l
Copper (Cu)	-0.1354	-0.1318	2.00mg/l
Cobalt (Co)	-0.1863	0.3592	0.05mg/l

The results of the study area as presented in figures 2 – 6 and table 1. the measured data was converted to apparent resistivity by multiplying the resistant with the Geometric

Factor, K; the modelled curves obtained reveal multi-layered earth in the study area which are three (3) geoelectric layers with resistivity values ranging from (0.529 - 2194508) Ωm. The apparent resistivity values are obtained by increasing the electrode spacing about a fixed point are plotted in a log-to-log scale against half the electrode spacing (AB/2) to get a few resistivity curves. VES 1 showed sounding curve of A-Type ($p_1<p_2<p_3$), while VES 2, showed curve Ak-Type ($p_1<p_2>p_3$) and lastly VES 3, curve to be A-Type ($p_1<p_2<p_3$). Groundwater is likely at a depth of 2m down below; an indication that water bearing layer is shallow, inferred that groundwater is prone to contamination. Table.2 represents the concentrations of heavy metals in groundwater of the study area, the values were also compared with World Health Organization (WHO) permissible standards; however, the mean concentration of the Zn, Ni, Mn, Pb, Fe, Cu, Co, where ppm is parts per million or milligrams per litre (mg/l)

CONCLUSION

The study was conducted by applying geophysical method using Schlumberger array for the VES sounding, used to locate underground water depth to be likely 1.34 m and inferred lithology (topsoil, sand clay) of the subsurface layers, which is part of a sedimentary basin of Southern Nigeria. Water samples were analysed to indicates the concentration level of some heavy trace metals of the study area, which indicates that Cobalt (Co) of 0.3592mg/l was high at sample 2, when compared to the WHO standard permissible limit for water, which implies its possibility of harmful effect to humane and plant system of the study area (Tantua – Amassoma community).

REFERENCES

Bunonyo, T.Y., Ohioma, I.O. and Marere, O. (2018). Application of geoelectric method to characterize subsurface in Ogbia local government area, Bayelsa State, Nigeria, NJP Journ, vol 27(1), P 59-66.

Ekine A.S. and Osobonye G.T. (1996). Surface geoelectric sounding for the determination of aquifer characteristics in part of Bonny Local Government Area of River State, Nigeria. J, Phys., 85, p 93-97

Ibuot J.C., Obiora D.N., Ekpa M.M.M., Okoroh D.O. (2017b). Geoelectro hydraulic investigation of the surficial aquifer unit sand corrosivity in parts of Uyo L. G. A., Akwa Ibom State. Southern Nigeria Appl Water Sci 7:4705–4713.

Killer, G.V. and Frischknecht F.C. (1966). Electrical methods in geophysics prospecting, Pergamon, London.

Makeig K.S. (1982). National buffers for sludge leachate stabilization of groundwater. Geophysics 20(4):420–429.

María M.S., Agustin L.G., Adriana L.S., and Pedro M.R. (2014). Assessment of the Microbiological Quality of Groundwater in Three Regions of the Valencian

Community (Spain), International Journal of Environmental Research and Public Health, vol. 11, pp. 5527-5540, ISSN 1660-4601, doi:10.3390/ijerph110505527

Tiwari R. N., Shankar, M., and Prabhat P. (2013). Study of major and trace elements in groundwater of Birsinghpur Area, Satna District Madhya Pradesh, India. Academic Journals vol.5 [7], pp. 380-386.