

This **research paper** is licensed under the Creative Commons Attribution 3.0 Unported License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

ISSN 0126-2807

Volume 8, Number 3: 171-178, September, 2013

© T2013 Department of Environmental Engineering Sepuluh Nopember Institute of Technology, Surabaya

& Indonesian Society of Sanitary and Environmental Engineers, Jakarta

Open Access http://www.trisanita.org/jases



International peer-reviewed journal

**IMPACT OF WASTE DISPOSAL SITE ON GROUNDWATER**

**AT BOLORUNDURO AREA OF AKURE, ONDO STATE, NIGERIA**

ODUNAIKE, R.K.1, LAOYE, J.A.1, ADEBESIN, B.O.2, INYINBOR, A.A.3\* and DADA, A.O.3

1Department of Physics, Olabisi Onabanjo University, P.M.B. 2022, Ago-Iwoye, Nigeria.

2Department of Physical Sciences (Industrial Physics Unit), College of Sci. & Engineering, Landmark University, Omu Aran, Kwara State.

3Department of Physical Sciences (Industrial Chemistry Unit), College of Sci. & Engineering, Landmark University, Omu Aran, Kwara State.

\*Corresponding Author: Phone: +2348034661303; E-mail: Inyinbor.adejumoke@landmarkuniversity.edu.ng

Received: 4th June 2013; Revised: 11th July 2013; Accepted: 19th July 2013

**Abstract:** The improper dumping of refuse has caused not only water contamination but also air, sea, and land pollution. This can be corrected by geophysical investigation of the earth which involves taking measurement. A detailed of the environmental evaluation is carried out using electrical resistivity method with schlumberger electrode configuration. A total of 13 VES were carried out. The parameter generated was estimated from the combination of geoelectric parameter resistivity, p, and thickness h, this was contoured and presented as map. It enabled the classification of the protective capacity of the study area (Bolorunduro) into excellent (>10) very good (5-10), good (0.7-4.9), moderate (0.2-0.69), weak (0.1-0.19) and poor (<0.1) protected capacity. The data was subsequently processed and interpreted based on an assessment of the contour and geoelectric sections while, the quantitative interpretation comprises iterative computer model using a finite difference algorithm. The geoelectric sections revealed a maximum of four layers consisting the topsoil, clay/clayey sand, laterite/sand, weathered/ fractured basement and the fresh basement. The investigation reveals that the aquifers in the southern and south eastern portion of the study area are poorly protected. The interpretation shows a depth to aquifer horizon varies from 8.7m-27m.

**Keywords:** Geophysical investigation, electrical resistivity, schlumberger electrode, configuration

**INTRODUCTION**

The application of geophysical method in environmental studies explains the importance and reliability of ground water of quality and quantity [1]. Therefore there is need for good understanding of environmental pollution and its necessary requirement for its treatment, which includes lithlogy, porosity permeability of the aquifer on one hand and dissolved mineral constituents of the ground water in such aquifer. Pollution is caused by waste material from industries and sewage disposal environmental pollution when both household and industrial waste is disposed improperly.

Geophysical method when integrated with soil chemical and hydrological method can be use to investigate groundwater contamination which pollute the aquifer that it recharges. Precipitation on the refuse disposal site will either infiltrate the refuse or run off as overland flow. In open dump there is highly compacted. In sanitary landfills, the rate of infiltration is governed by the permeability and infiltration capacity of the soil used as cover for refuse [2] If water table is above the bottom of the refuse deposit, the percolating water travels only vertically through the refuse of the water table. In vertically percolation the water leaches both organic constituent from the refuse. The important fact is that waste contaminates both the surface and the ground-water. It is important to note that general environmental contamination has direct effect on our access to subsurface resource.

According to Mazac *et al.* [3], in a geological setting which waste disposal is situated on limestone aquifer. The CaCO3 which is used for production of cement contaminates groundwater, and as a result becomes hard. The hardness in water as a result of calcium need to be treated or else the water will not be good for drinking, washing and bathing, thus rendering it useless. Underground water when using vertical electrical sounding can be contaminated because electrical conductivity is directly related to the dissolved solute content in water. And the findings of this study contribute to the effort of ground water protection and can be use for assessment of installation sites of monitoring wells.

**MATERIALS AND METHODS**

Bolounduro lies within the South Western part of the Nigeria basement complex. Its metasediments have been classified lithologycally as a formation. It also occurs as miogeosyndinal supracrustal cover in the migmatite gneiss complex and is believed to be considerably younger than later. The area is situated in the western part of Nigeria and therefore falls within Precambrian basement complex terrain of the country [2]. The main rock types fond in Bolounduro area are the undifferentiated granite gneiss, quartzite and porphyritic granite with schist impregnation

The aim of this paper is to determine the protective capacity of the soil to contaminants from the subsurface within the study area. The hydrogeological and hydrogeophysical knowledge of the site surveyed is required to accomplish this effectively. However, the geophysical survey of the study area was carried out at Bolorunduro area of Akure. Result obtained from each VES was computered and interpreted in order to determine the protective capacity of the study area.

It is used to reveal the subsurface lithology setting of the study area. The baseline study is expected to be use for future environmental impact assessment and (E,A) and environment auditing (EA) of the area in accordance with Nigeria government and international guide. The area understudy has two distinct seasons which are wet and the dry season. The dry seasons starts from October through February, which is characterized by harmattan while the wet season occurring between March and October, which is best known as rainy season. The month of December seems to be the driest month without rain The mean annual rainfall ranges 700m to 800m approximately. The evaporation here is high due to the humidity and relatively high sunshine hours and low precipitation. The stream flows in northwest to South East.

**Electrical resistivity prospecting method**

This is one of the most diversified geophysical methods comprising a variety of technique such as electrical resistivity; spontaneous or self potential and induced polarization [4]. Each of these techniques depends on one or a combination of different electrical properties of materials in the earth. This method is widely used in engineering site investigation determination of depth of bedrock, structural mapping, integrity of the bedrock etc. However, success in the subsurface conduction changes the mode of current flow within the earth and this affects the distribution of electrical potential in the earths surface. It also depends on size, shape and composition as well as the electrical resistivities of the subsurface formation. The method involves the passage of electric current usually direct current or low frequency alternating current) into the subsurface, through two electrodes. The potential difference is measured between another pair of electrodes, which may or not be within the current electrodes depending on the electrodes array in use. Actual resistivity of subsurface layer is determined from the ground apparent resistivities which are computed from the measurement of current and potential differences between the electrodes placed on the surface.

**Theory and principles of electrical resistivity method**

Measurement of earth resistivity in electrical resistivity method makes use of the assumption of homogeneous and isotropic medium of the earth [5]. The equation expressing the potential about the current may thus be developed from Ohm’s law. The current (I) which flows through a conductor is directly proportional to the potential difference (V) across the ends of the conductors, provided that temperature and all other physical conditions are kept constant. i.e

V = IR (1)

where V = Potential difference between any two points in votts

I – current flowing in the conducting medium between two points in amperes.

R = Resistance of the medium between any two points in ohms.

The resistivity ρ is known to be directly proportional to the length (L) and inversely proportional to the cross sectional area (A) of the conductor through which the current flowing

R = ρL/A (2)

where p is the resistivity of the medium , measured in ohms meter (Vim ). From equation

R- V/ I (3)

Substitution from R in equation (2) using equation (3)

V / I = L/A = V /IL (m)… (4)

Equation 4 is the resistivity equation for homogeneous and isotropic medium, which is in form of cylinder, for the semi – infinite heterogeneous medium. Equation (4) is not applicable in such case, the resistivity will have to be defined for a unit cell.

**Electrical field procedure**

The electrode array is the manner of arrangement of the current and potential electrodes on the field. The choice of array is usually influenced by the objectives of the survey i.e. the dept of investigation and convenience. The electrode array is use for schlumberger survey There are factors that affect the resistivity of the earth i.e. porosity, rock texture, pressure, permeability, temperature, degree of water (Fluid) saturation. There are factors that also favour the resistivity it includes:-

1. Existence of simple geological features
2. Existence of suitable contrast in the electrical property
3. existence of large expanse of land to work with little or no restriction
4. availability of electrolyte in formation

The vertical electric sounding was used in measuring vertical variation of ground resistivity. The electrodes are placed in a straight line and the inter-electrode spacing is gradually increased about a fixed centre. It is applicable in determining of overburden thickness, structure and resistivity of basement rocks.

**RESULTS AND DISCUSSION**

This section presents the results of quantitative interpretation of 13 schlumberger VES curves. The geoelectric parameters (Layer Resistivities and thickness) derived from the field data are presented in Table 1. The curves obtained across the study area are A, K, O, and KP11. The predominant curve type is the KP11 in which geoelectric setting is believed to have reliable geologic significance [6]. The curves show the geoelectric complexity often associated with basement terrain and the topsoil varies in composition from sand to clay/clayey, sand sandy and weathered/ fractured basement

**Table 1: Layer Resistivities and Thickness derived from the field data**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| VES  `NO | | LAYER  NO | RESISTIVITY  (Ω-M) | | THINCNESS (M) | DEPTH  (M) | PROBABLE  LITHOLOGY | CURVE  TYPE |
| 1 | | 1  2  3  4 | 65.2  1869  10.2  8886.9 | | 0.2  3.2  5.3 | 0.2  3.4  8.7 | Top soil  Clayey sand  Clay  Fresh basement | KH |
| 2 | | 1  2  3 | 46.0  58.8  145.4 | | 0.7  27.7 | 0.7  28.4 | Top soil  Clayey sand  Clay  Fresh basement | A |
| 3 | | 1 | 23.1 | | 0.4 | 0.4 | Top soil | Kll |
|  | 2  3  4 | | 104 46.6  2384.1 | 25.4  0.4 | | 25.7 | Clayey Sand Weathered Basement Fresh Basement |  |
| 4 | 1  2  3  4 | | 83.3  118.9  106.2  648.6 | 0.5  3.4  16.4 | | 0.5  3.9  20.4 | Top soil  Clayey sand  Weathered  basement | K |
| 5 | 1  2  3 | | 22.3  302.8  194.7 | 1.4  5.3 | | 1.4  6.7 | Top soil  Sand  Clayey Sand | Kll |
| 6 | 1  2  3  4 | | 113.5  195.3  12.7  1108.6 | 1.2  8.1  7.1 | | 1.2  9.3  16.4 | Top soil  Clayey sand  Clay  Fresh basement | Kll |
| 7 | 1  2  3  4 | | 53.2  252.7  37.1  6220.5 | 0.3  2.0  25.5 | | 0.3  2.4  27.6 | Top soil  Clayey sand  Clay  Fresh basement | Kll |
| 8 | 1  2  3  4 | | 126.0  226.9  29.6  1697.2 | 0.4  3.8  21.2 | | 0.4  3.8  21.2 | Top soil  Clayey sand  Clay  Fresh basement | Kll |
| 9 | 1  2  3  4 | | 127.0  497.0  106.5  1256.3 | 0.3  3.5  27.1 | | 0.2  3.7  30.9 | Top soil  Clayey sand  Clay  Fresh basement | Kll |
| 10 | 1  2  3 | | 243.7  430.1  137.8 | 0.4  4.1 | | 0.4  4.5 | Top soil  Clayey sand  Clay | AA |
| 11 | 1  2  3 | | 1210.8  494.1  39.5 | 0.1  6.0 | | 0.1  6.1 | Sandy Top soil  Sand  Clay | Q |
| 12 | 1  2  3  4 | | 57.3  111.7  23.4  406.6 | O.2  5.5  12.8 | | 0.2  5.6  18.4 | Top soil  Clayey sand  Clay  Fresh basement | Kll |
| 13 | 1  2  3  4 | | 113.3  868.2  8.9  1701.2 | 0.6  1.6  7.2 | | 0.6  2.2  9.3 | Top soil  Clayey sand  Clay  Fresh basement | Kll |
|  |  | |  |  | |  |  |  |

The geoelectric section shown consists of the following VES points 1, 2, 5, 8, 10. The resistivity value of the topsoil ranges between 2.3Ω-m to 2.49Ω-m with thickness between 0.2m to 1.4The second layer is made up of clayey sand 1,4, 8 range between 3.2m to 3.8. The third layer along the southwest to the southeast part and is made up of clay to clayey sand and sand. Hence, considering the Table1, the resistivity value is low; containing high clayey material in the subsurface. The fourth layer is mainly the weathered/ fractured basement extending to the fresh basement.

**Geoelectric section along the west to the east portion of the study area**

The geoelectric section consists of VES 2,3,6,7, &9.The first part of the geoelectric section which is the topsoil, is mainly made upon of clay /clayey sand. VES 2, 3, 7, and 9 resistivity value of clay ranges from 23.1 Ω–m to 86 Ω-m with thickness of 0. 3m to 0. 7m. However, the layers extends to clayey sand in VES 6, with resistivity value of 113.2 O and thickness of 1.2m. The second layer consists of both clay/clayey sand. VES 3,6, & 9 are made up of clayey sand with resistivity value of 104.5 Ω-m to 195.30m with thickness of 1.8m to 25.4m. The third layer is composed of clay with resistively value ranging from 12.7 Ohm to 46. 6 Ohm with thickness of 0.4m to 18,8m, the last layer extends to the fresh basement with resistivity value ranging from 1108.6Om to 128 6.2Om.

**Geoelectric section along the north direction**

The geoelectric section consists of maximum of 4 layers. The resistivity values of the top soil ranges from 57 Ohm to 1210 Ohm with thickness of 0.1m to o.6m. The second layer is composed of sand (not present in VES 12), VES 12 is made up of clayey sand with resistivity of 132 Ohm and thickness of 5.5m. The third layer of VES 11, 12, 13 is mainly clay with resistivity of 8. 9O m to 39 Ohm. The thickness ranges from 7.2m to 12.8m. The fourth layer of VES 11, 12.13 extends to the fresh basement Table 2 shows the modified longitudinal/ conductance/ protective capacity rating. Figure 1 shows a contour map of variation for longitudinal conductance value of the overburden of the study area. These value ranges from 0.05mhos 0. 8ohms.



Fig. 1: Contour map of variation for longitudinal conductance resistivity of the study area

Areas of high values (>0.7) are peculiar to the southwest central portion and the northern portion (VES 7.8.13) of the study area are characterized by material of good moderate productive capacity. This implies that area of high clay content with low resistivity value, are resistive to contamination and pollution. Areas of moderation constitute the major protective capacity of the study area. The moderately protective zones are peculiar to VES 1, 2, 3, 4, 6, 9 and 12, the VES location 5, 10, and 12 falling within southeast southwest portion of the study area exhibit weak / poor protective capacity, these weak / poor protective capacity areas are vulnerable to environmental problems.

Table 2: modified longitudinal / Conductance / protective capacity rating

|  |  |
| --- | --- |
| Longitudinal Conductance (mhos) | Protective capacity rating |
| 7- 10 | Excellent |
| 5-10 | Very good |
| 0.7-49 | Good |
| 0.2-0. 69 | Moderate |
| 0,1-0,19 | Weak |
| <0.1 | Poor |

**CONCLUSION**

The fact is that, waste affects our environment which affects our living in the sense that, if the environment is polluted, it affect lives in the community through water, air etc. In the same vain, the precipitation of refuse, either infiltrate or causes run off. When it runs off it does not contaminate the ground and water in it i.e if the area is clayey in nature, the clay retains water and oil in which the water may not be contaminated. But when it enters, it contaminate and pollute the water in the community i.e if the soil is sandy, it retain no water and therefore filters into the ground. VES is use to determine whether water is in the environment. And this result present quantitative interpretation of 13 VES of geophysical data obtained within Bolorunduro, Akure.

The result interpreted shows that the protective capacity increases with high clay content and thickness. From the map an attempt has been made in classifying the protective capacity of the area of zone based on the relative clay content and the overburden thickness. The zones of good to moderates fall within lower resistivity value, with thicker overburden.

**RECOMMENDATION**

Industrial waste disposal within the study area should be channeled from southwest to the northern position of the study area. The southern portion is vulnerable to contamination and pollution hence, bore hole should be ceased to prevent seepage of industrial waste product. The consumption of hand dug well should be discouraged while traditional pit latrine should be discouraged as well to prevent shallow aquifer unit from pollution. Future researchers should include soil corrosives survey with this report for more integration and discussion of result.

**References**

1. Griffiths. D.H and Ring R.F, 1981. Theory of Electrical resistivity Surveying practical and Application in Resistivity Surveying APP GRY for Geologists and engineering Paragon press, 2nd Edition Pages 70 – 111.
2. Rahman M.A., 1976. Review of Basement Geology of South Western Nigeria; Geology of Nigeria, Elizabeth publishing company pp 4-58.
3. Mazac O. Kelly, W.E., and Linda I., 1987. Surface Geophysics for groundwater pollution an I protection studies. J. Hydrogeology, pp 271-294.
4. EVANS, R.B., 1982. Currently available geophysical methods for use in hazardous waste site investigation (pp.93-119).
5. Orellana and Mooney, 1966. Two-Layer Apparent Resistivity Curves and Auxiliary Curves.
6. Jones H.A and Hocke R.D. (1964) The Geology of part of Southwestern Nigeria Geological Survey Bull 31.
7. Groundwater Research, 1986. Training on Groundwater Investigation procedure, Dept N.W. R,I Kaduna