JASEM ISSN 1119-8362

Full-text Available Online at www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage. *June*, 2007
Vol. 11 (2) 61 - 64

Geoelectrical Evaluation of Waste Dump Sites at Warri and its Environ, Delta State, Nigeria

[1]OTOBO EGWEBE; [2]AIGBOGUN, C O; [1]IFEDILI, S O

[1]Department of Physics, University of Benin, Benin City,
[2]Department of Physics, Igbinedion University, Okada, Edo State.

ABSTRACT: The existing waste dump sites in Delta State were investigated without soil disturbance by using the vertical electrical sounding (VES).The soil overlying the aquifer at Ovwian-Aladja dump site has resistively values, 11.84-85.50 Ohm-m, thicknesses,21.10-31.83m and at depths less than 1m, while at Warri it has resistively values, 160-1074 Ohm-m, thicknesses, 1.53-7.87m, and at depths less than 1m. The soil overlying the aquifers in the dump sites have been identified and the implication to the quality of the sites discussed. @JASEM

In protecting the groundwater against oil pollution, it is advisable to locate, identify and quantify contaminated areas (Mazac and Landa,1978).To determine the extent of oil contamination by drilling operation is usually time consuming and difficult, if not impossible due to dense land coverage (Kelly,1976). However, due to low survey expenditures and high reliability the geoelectrical surface method ranks first among the most important methods used in selecting the location of dumps as well as in determining the quality of dumps sealing (Stollar and Roux, 1975). The optimium location of the dumps and the high quality of sealing is a guarantee of low or negligible contamination of the geological environment especially of groundwater (Mazac,et.al.,1990). Moreover, the use of geoelectrical survey in sensing buried waste and waste migration has been documented (Belan et.al.,1984; Saksa et.al.,1985; Asch et.al.,1986; Fountain,1986). The mapping of the configuration of underlying clay layers as well as the near surface discontinuities of landfills and buried disposal trenches has been reported (Ross et.al.,1990). The earlier workers (Griffiths et.al,1981; Finch,1979) mainly used the screening body and profiling, and VES was only used for either locating buried waste trenches or checking of foil quality of the dumps immediately after construction and during the operation of the foil sealing system which is a down hole method. The investigation using the VES has not been attempted by any previous investigator in Nigeria. Therefore, the aims and objectives of this study is using the VES method as a viable tool for accessing existing waste sites.

Study area: The Warri and Delta Steel Company Ltd waste dump sites are located within Delta State in ($5^0$20'N ; $5^0$43'E) and ($5^0$00'N; $5^0$46'E) respectively. These areas and environs (Figure1) are underlain by Quaternary sands belonging to the Sombreiro Deltaic Plain of the Niger Delta Basin and comprises chiefly of sands and clays (Short and Stauble,1967). Other geological characteristics of this areas have earlier been described by Allen (1965). The typical tropical climate, consisting of dry and rainy seasons is governed by the northeastern and southwestern winds which generally influence the climate of Nigeria (Hare and Carter,1984). The area lies within the rainforest region of the Niger Delta (Allen,1970).

MATERIALS AND METHODS

Vertical electrical sounding was carried out in the dump sites with an ABEM Terrameter SAS 300C with a booster SAS 2000 to enhance current penetration. The survey was completed with four(4) sounding stations in dry season of 2004 using the Schlumberger array with a maximum current electrode spacing (AB) of 294m.The field data acquisition was generally carried out by moving two (current electrodes) or four of the electrodes used between each measurements along a straight path and level ground to avoid lateral inhomogeneity. Details of the method have been documented (Telford et.al.,1976).

The VES curves were obtained by plotting the calculated apparent resistivity against electrode spacing. The curves were interpreted by the well-known method of curve matching and the results were subjected to computer assisted iterative interpretation. The computation employs a 9-point digital linear filters (Koefoed,1979). The resulting sets of layer parameters were interpreted in terms of their lithologic equivalents called geoelectric sections.

Corresponding author: *Email: oegwebe@yahoo.com ,+234-803-091-1009*

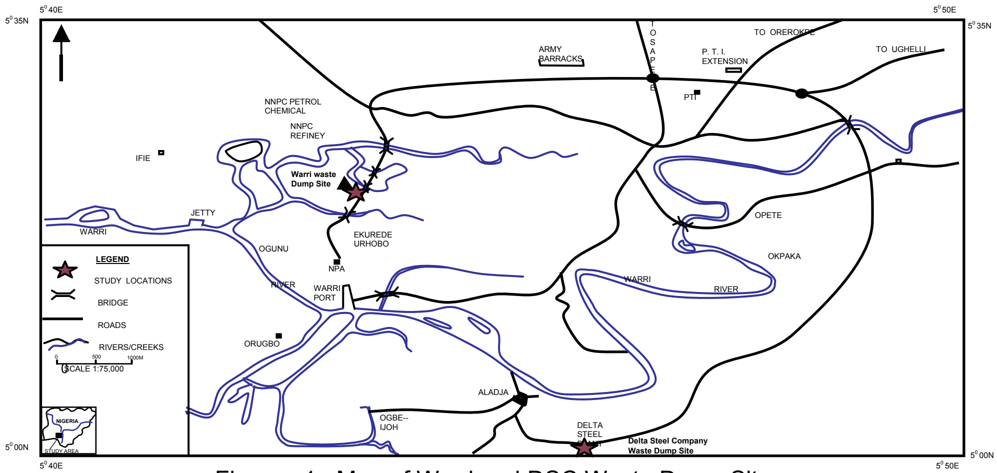

Figure. 1: Map of Warri and DSC Waste Dump Sites

RESULS AND DISCUSSION

Table 1: Measured Apparent Resistivity values in Warri (VES 1 and 2) and Delta Steel Company (VES 3 and 4) waste dump sites.

AB/2 (Current Electrode Spacing) (m)	Apparent Resistivity (Ohm-m)			
	VES1	VES2	VES 3	VES4
1.00	230.00	406.00	58.00	89.00
1.47	220.00	462.00	67.00	55.00
2.15	240.00	465.00	70.00	37.00
3.16	306.00	423.00	63.00	25.00
4.64	372.00	351.00	49.00	18.00
6.81	455.00	293.00	34.00	12.00
10.00	534.00	284.00	24.00	10.00
14.70	576.00	373.00	17.00	10.30
21.50	618.00	553.00	16.50	11.50
31.60	586.00	760.00	20.00	14.00
46.40	555.00	917.00	27.00	19.00
68.10	515.00	912.00	36.00	27.00
100.00	423.00	810.00	45.00	39.00
147.00		675.00	48.00	

Table 2; Derived Geoelectric Section in Warri Waste dump site (VES 1and 2).

Geoelectric Layer	VES 1 App.Resist (Ohm-m)	Thickness (m)	VES2 App.Resist (Ohm-m)	Thickness (m)	Derived lithology Top soil (sand)
1	240.00	0.85	358.00	0.90	sand
2	160.00	0.68	1074.00	1.35	sand
3	760.00	7.65	206.13	5.52	sand
4	672.00	28.88	920.80	24.00	sand
5	263.14	-	613.80	17.50	sand
6			405.68	-	sand

Table 3 Derived Geoelectric Section in Delta Steel Company Ovwian-Aladja Waste dump site (VES 3 and 4).

Geoelectric Layer	VES 3 App.Resist (Ohm-m)	Thickness (m)	VES4 App.Resist (Ohm-m)	Thickness (m)	Derived lithology Top soil (sand)

1	57.00	0.80	85.00	0.80	clay
2	85.50	1.60	17.00	2.40	clay
3	15.00	19.50	11.84	7.00	clay
4	85.00	-	19.83	22.43	clay.
5			135.00	-	sand

Table 1 shows that the measured apparent resistivity values for Warri dump site (VES1 and VES2) are higher than 100 Ohm-m, and those for Delta Steel Company dump site (VES3 and VES4) are lower than 100 Ohm-m. Also the apparent resistivity values for the derived geoelectric sections for VES1 and VES2 are above 100 Ohm-m (Table 2) and those for the sections in Delta Steel Company (VES3 and VES4) are below 100 Ohm-m (Table 3)

Figure 2 shows that the field curves for Warri waste dump site (VES1 and VES2) have a bell shape at the right most segment and an ascending left most segment. Also shown in Figure 2 are the field curves for Delta Steel Company waste dump sites (VES3 and VES4) which have a middle bowl section, a descending left most and an ascending right most segments.

The apparent resistivity values of over 100 (160-1074) Ohm-m (Tables 1 and 2) and is confirmed by the bell shapes with ascending left most segments in the field curves for VES1 and VES2 (Figure 2). This indicate the presence of sandy soil (permeable soil) above the near surface aquifer in Warri waste dump site. However, the left most descending and the middle bowl segments of VES3 and VES4 in Figure 2 is an indication of the low apparent resistivity values (less than 100 Ohm-m) as shown in Tables 1 and 3, this means that a thick clayey (impermeable) soil is present above the aquifer in Delta Steel Company waste dump site.

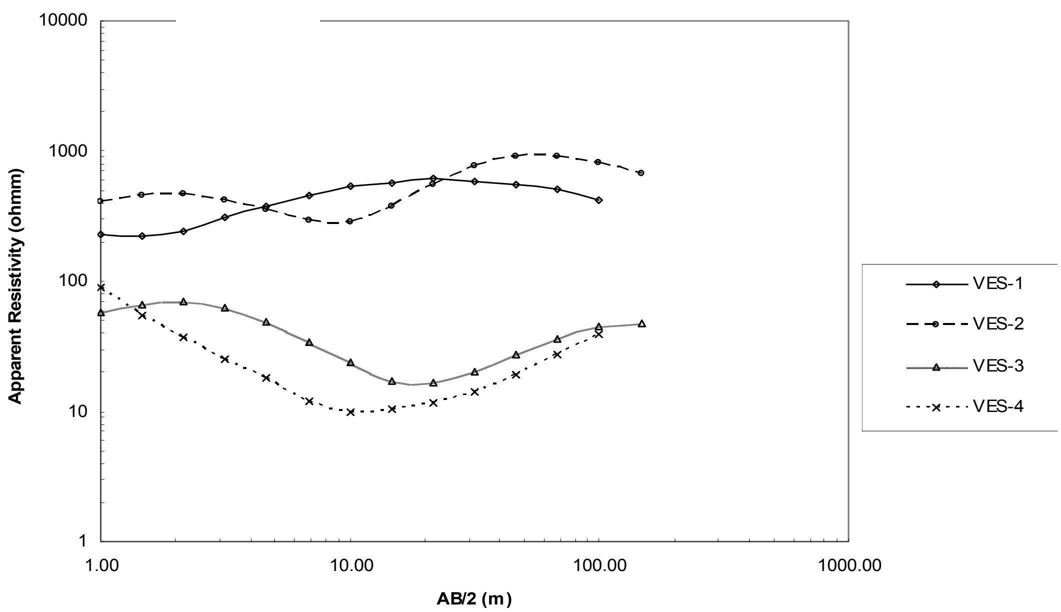

Figure 2: Shape of VES Curves in Warri (VES1 and VES2) and Delta Steel Company (VES3 and VES4) waste dump sites.

The presence of 4.5m thick horizontal impermeable (clay) layer above an aquifer can limit the danger of contamination of the aquifer (Fejes and Josa,1990 ; Egwebe,2003).Therefore, the clay of thicknesses ,21.10-31.83m above the aquifer in the Delta Steel Company waste site is capable of protecting the aquifer from contamination. According to Abu-Hassanein et.al.,(1996) resistivity values above 100 Ohm-m indicate the presence of a sandy subsurface, therefore, the Warri dump site where the resistivity values are above 100 Ohm-m has an aquifer that is overlain by sands and it is exposed to contamination.

It is strongly recommended that a thorough study of any project site (especially those that involves poisonous by products) be done before any operation so as to know whether the aquifer is naturally sealed or not. And the presence of clay above the aquifer must be sought for before choosing any site for waste disposal. Also all existing waste dump sites in

Nigeria should be investigated using VES, and the usage of any site without shallow clay of at least 4.5m thick above the aquifer must be discouraged.

Acknowledgments: We are grateful to the management of Zino Mikedo Int. Ltd, Warri, for sponsoring the field work.

REFERENCES

Abu-Hassanein,Z S; Benson,C H ; Blotz,L R (1996). Electrical Resistivity of compacted clays, Journal of Geotechnical Engineering, 122(5), 397-406.

Allen, J R L (1965). Late Quaternary of Niger Delta and adjacent areas.Bull. A.A.P.G. 49, 547-600.

Allen, J R L (1970). Sediments of the modern Niger Delta: A summary and review in Deltaic sedimentation:(ed.by Morgan, J.P.); Special publications Soc.,Econ.Paleontologists and mineralogists. pp. 138-151.

Asch, T; Morison, H F; Dickey, S (1986). Interpretation of borehole to surface DC resistively measurements at a contaminant site. A case study: Proc. Surface and Borehole Geophys. Methods and Ground water instrumentation. Nat. water well. Assoc, Conf. and Expos, pp. 127-150.

Belan, R A; Lessely, S D; Ross, H P (1984). Hill AFB, Utah Installation restoration programme phase HB IRP survey. Final Rep. Utah Biomed. Tech. Lab. Univ. Utah Res. Inst. Pp 321-328.

Egwebe ,O (2003). Environmental geophysics: Site characterization of the Delta State Region of the Niger Delta by Electrical Resistivity Methods. Ph.D. Thesis, University of Benin, Benin City. pp306

Fejes, I.; Josa, E (1990). The Engineering Geophysical sounding Method. Principles, Instrumentation, and Computerised Interpretation. In S.H.Ward (ed),Geotechnical and Environmental and Groundwater S.E.G. Publications. pp.321-3.

Finch, J W (1979). An application of surface electrical resistivity methods to the delineation of spoil tip leachate: Proc. Sympos on the Eng. Behaviour of Indust and Urban fill.Med. Geotech.Soc., Univ. of Brimingham.pp 123-127.

Fountain,L.S (1986). Detection of location of leaks in geomembrane- lined liquid waste impoundments using an electrical technical, Proc. Surface and Borehole Geophys. Methods and Groundwater Instrumentation. Nat water well Assoc. Conf. and Expos. pp.117-146.

Griffiths, D H; Barker, R.D; Finch, J W (1981). Recent applications of the electrical resistively and induced polarization methods of hydrogeological problems in a survey of British hydrogeology. The Royal Soc., London, pp 85-96.

Hare,L. ; Carter, J C H (1984). Deil and seasonal physio-chemical fluctuations in a small natural West African Lake. Freshwat.Biol. 14, 597-610.

Kelly, W E (1976). Geoelectric sounding for delineating groundwater contamination:Ground water. 14, 6-10.

Koefoed, O (1979). Geosounding Principles I: Resistivity sounding measurements, Elsevier Science Publishing Co., Amsterdam-Oxford New York. p. 276.

Mazac, O; Landa, I (1978). The application of vertical electrical sounding in treating the problems of groundwater contamination by petroleum hydrocarbons: Proc. Inter. Symp on Groundwater Pollution by Oil Hydrocarbons Pralia ,pp 351-361.

Mazac , O; Benes , L; Landa. I; Skutham, B (1990). Geoelectrical detection of sealing
foil quality in light- ash dumps..In. S.H. Ward (ed) Geoelectrical and Environmental and Groundwater S.E.G., Publication. pp 113-119.

Ross, H P; Mackelprang, C E; Wright, P M (1990). Dipole –Dipole electrical resistivity surveys at waste disposal study sites in Northern Utah. In. S.H. Ward (ed) Geotechnical and Environmental and Groundwater .S.E.G Publication, pp145-152

Saksa, P; Kaila, J; Hassiene P (1985). Application of geophysical methods to environmental and municipal engineering paper presented at Norkdiska eofysikermotet (NOFTIG), ESPOO, Finland. pp 322-327.

Stollar, R L; Roux, P (1975). Earth resistivity surveys a method of defining groundwater contamination: Groundwater . 13, 145-150.

Telford, W; Geldart, L; Sherrif, R; Keys,D (1976). Applied Geophysics. Cambridge University Press. pp 680.