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Geo Environmental Investigation of Abuad Dumpsite, Southwestern Nigeria

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ABSTRACT
Geoenvironmental study of ABUAD female dumpsite was conducted to investigate the suitability of its location and potential impact on groundwater in the environment. Profiling and Vertical electrical sounding methods were employed using Dipole - Dipole and Schlumberger configuration respectively. Five points were sounded and one profile was occupied. Three heterogeneous subsurface lithologic units were established namely; lateritic topsoil, clayey-sand, and, fresh basement. The curve types are simple H and HA. The topsoil and clayey-sand materials are characterized with relatively low resistivity values while the fresh basement materials are characterized with high resistivity values. The average resistivity and thickness values for the topsoil are 280.0Ωm and.2.3m respectively. Clayey-sand was encountered in all the locations with average resistivity and thickness values of 32.0Ωm and 7.3m respectively. Basement is relatively shallow in the study area, it was encountered in all the locations with an average resistivity and depth values to the top of basement of 674Ωm, and 9.6m respectively. Overburden materials are relatively thin within the area with an average resistivity and thickness values of 156Ωm, and 9.6m respectively. The overburden materials constituting the aquiferous units within the study area are porous, vulnerable, and good paths for leachate migration. The relatively low resistivity values within the clayey-sand layers (14 - 61Ωm) are suggestive of leachate intrusion, while relatively high resistivity values of the impervious basement are due to their crystalline nature. The proximity of the dumpsite to both the cafeteria and residential halls is a cause for concern.
KEYWORDS: Geoenvironmental, Suitability, Heterogeneous subsurface, Leachate migration, Impervious basement.

I. INTRODUCTION

Solid wastes are unwanted solid materials such as garbage, paper, plastics, and other synthetic materials, metals and wood that needs to be disposed.

Dumpsites are areas where wastes are dumped or buried. They are the cheapest and most common disposal method for solid waste but they quickly become overfilled and may contaminate air, soil and water.

Dumpsite related geo-electrical surveys had being carried out by numerous investigators in the study of leachate contamination of soil and groundwater. Bernstone and Dahlin (1999), Christopher and Jones (1999), Keller and Frischescht (1999), Powers et al. (1999), and Rosqvist et al. (2003), using 2-D dc resistivity imaging and vertical electrical sounding, estimated the depth to the groundwater, identified and delineated the extent of contaminant leachate plume and migration paths below surface around landfills.

Ehirim et al. 2009, used 2-D resistivity imaging of profile lines to isolate pollutants such as rock material contaminated with leachate plume and land fill gases as anomalously low or high resistive structures respectively.

Other Landfill related studies using the 2-D resistivity imaging method were also carried out by various authors (Olayinka and Olayiwole, 2000, Samsudeen et al, 2006, and Esmail et al, 2008). This is because of its inherent ability to detect vertical as well as lateral resistivity changes related to variations in fluid content, chemical composition, and contaminant migration.

Research on ground water contamination by landfills have also focused on the microbiology and chemistry of ground water (Hussein et al, 1989, Both and Vogt 1990, Asmuth and Stranberg, 1993), based on the laboratory analysis of groundwater samples.

The integrated use of geophysical and hydro physiochemical methods are often recommended in landfill studies (Bensoil et al, 1983, Mathias et al, 1994, kayabali et al, 1998).

Bayode et al, 2011 used a direct current electrical resistivity survey using the Schlumberger Vertical Electrical Sounding (VES) and dipole – dipole profiling techniques to map structurally controlled pollution plume around the Otutubiosun dumpsite, Akure, southwestern Nigeria.

The need for more studies and enlightenment campaigns exist and the job of creating awareness on healthy environmental practices needs to be viewed with more seriousness.

ABUAD dumpsite at the back of female hall of residence has being investigated to access the suitability of the location relative to the local geology and hydrogeology of the area, the appropriateness of its location, the practice and maintenance, and finally, the possibility or any actual negative implication on the immediate environs was also investigated.

II. LOCATION AND GEOLOGY OF THE STUDY AREA

2.1 Location

Afe Babalola University is located in Ado-Ekiti along Ijan road, opposite The Federal Polytechnics. The study area is located at the north-western part of the University behind female hall of residence. The terain is gently undulating, with topographic elevation ranging from 345m to 370m above sea level. Ado Ekiti is underlain by crystalline rocks made of Older granite, Migmatite and Charnockites, with little or no fracture in most location and shallow overburden.

2.2 Climate, Geology and Hydrogeology of The Area

The area is situated within the tropical rain forest region, with a climate characterized by dry and wet seasons. Average annual rainfall in this area is 1300 mm, with average wet days of about 100. The annual temperature varies between 18^0C to 34^0C. The study area lies within the basement complex of south-western Nigeria and is made up of; older granite, Migmatite and Charnockites. The overburden is relatively shallow within the study area with average of 9.6m. The groundwater is found within the overburden and fractured basement while the area is drained by the river Ogbese which flow SW-NE direction. The basement complex rocks are poor aquifers as they are characterized by low porosity and negligible permeability, resulting from their crystalline nature.

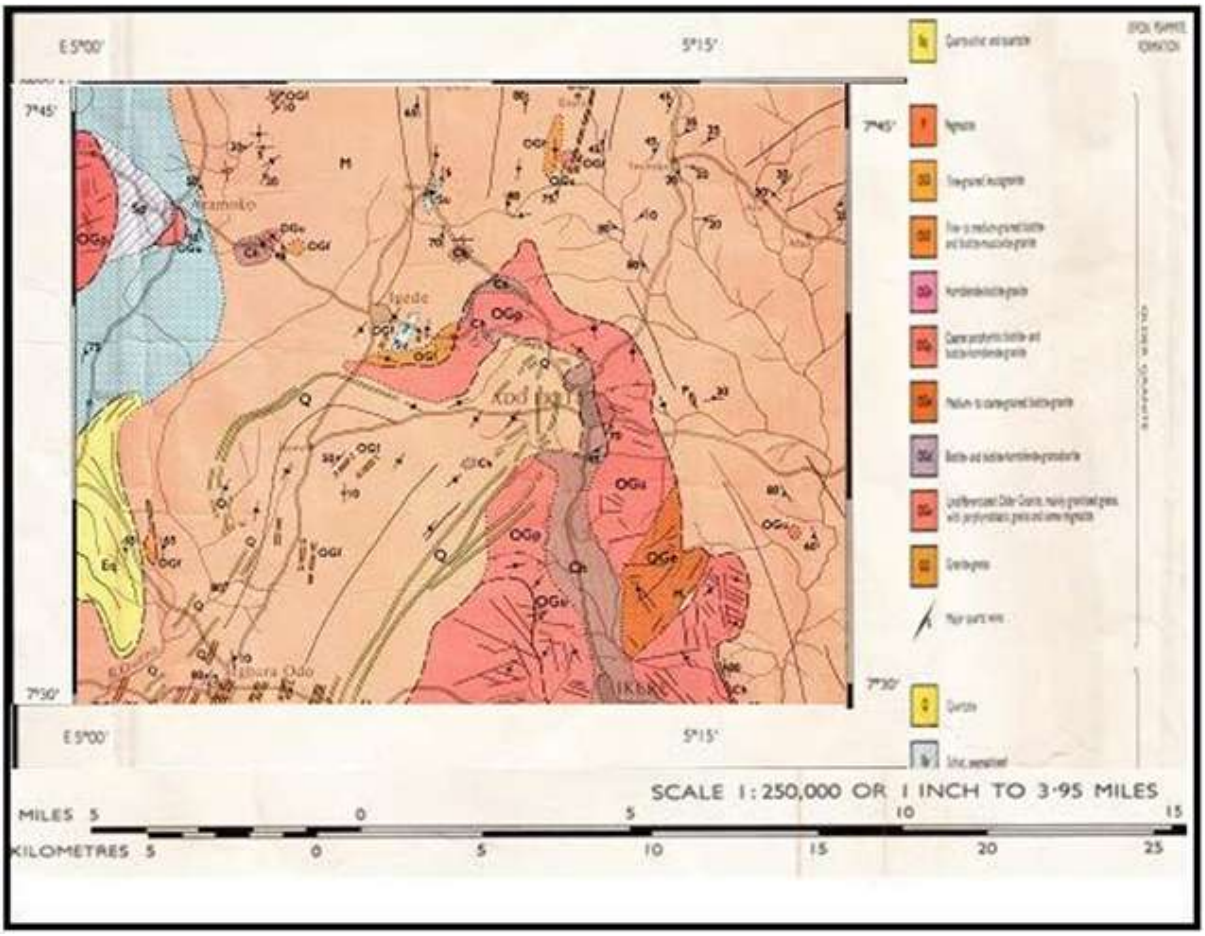


Fig. 1. Geology Map Of The Study area

III. Methodology, Data acquisition and Interpretation

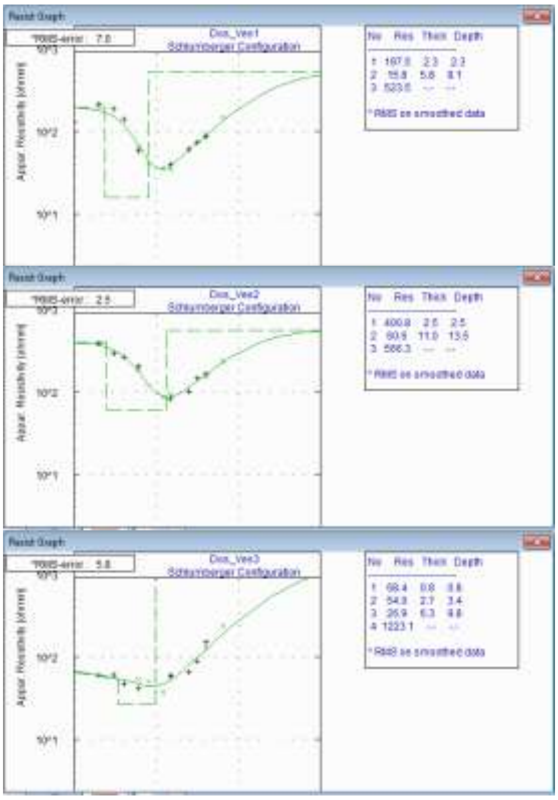
A reconnaissance survey of study area was carried out for site familiarization and planning. This was followed with geophysical investigation of the dumpsite and environs. Geophysical methods are indirect site investigation techniques and predominantly non-intrusive. Two methods namely Resistivity Sounding and Resistivity Profiling were adopted. Soil resistivity meter (PASI) was used for the geophysical tests. It is highly reliable and reproducible. Resistivity sounding was adopted in resolving resistivity variation with depth, thus sounding helped in delineating the various subsurface lithological units, hydrogeological significance and the protective capacity or vulnerability of the subsurface layers to possible pollution.

Resistivity profiling was adopted in resolving horizontal resistivity variation in this study, hence profiling helped in establishing the lateral continuity of the various subsurface lithological units.

IV. RESULTS AND DISCUSSIONS

4.1 Vertical Electrical Sounding

A total of 5 VES locations across 1 traverse was spread over the study area. The processed data were interpreted, resulting curve types were assessed, existing subsurface lithologic units were established, and the geoelectric properties of the various subsurface layers were used in delineating the aquiferous units in the study area. The results are presented in the form of table (Table 1), geoelectric curves (Figure 2) and sections (Figure; 3a & b, 4). Three different subsurface lithologic sequences were established namely; lateritic topsoil, clayey-sand and basement. The curve types range between simple H and HA. The topsoil and clayey-sand materials are characterised with relatively low resistivity values while the basement materials are typified with high resistivity values. A summary of the results of interpretation, on which the findings were hinged, is shown in figure 2 below.



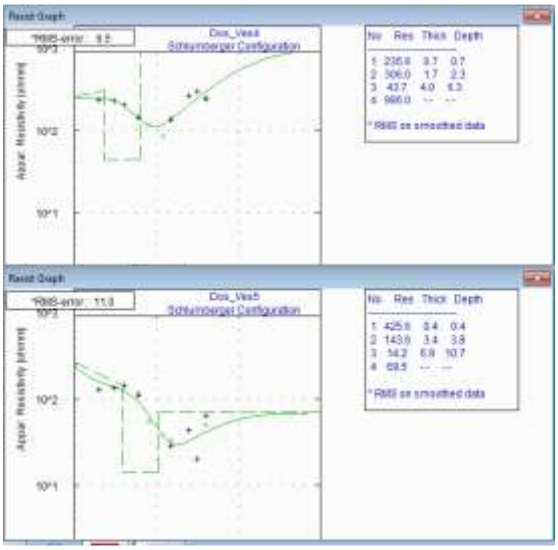


Fig. 2. Geoelectric curves from data interpretations

Table 1: Correlation Table

VES POINT		1	2	3	4	5
CURVE TYPE		**HA**	**HA**	**HA**	**HA**	**H**
LITHOLOGY						
TOP SOIL	TOP	0	0	0	0	0
	BASE	2.3	2.5	0.8	2.3	3.8
	THICKNESS	2.3	2.5	0.8	2.3	3.8
	Ωm	198	401	68	306	426
Clayey Sand	TOP	2.3	2.5	0.8	2.3	3.8
	BASE	8.1	13.5	9.8	6.3	10.7
	THICKNESS	5.8	11.0	9.0	4.0	6.9
	Ωm	16	61	27	44	14
BASEMENT	TOP	8.1	13.5	9.8	6.3	10.7
	Ωm	524	566	1223	986	70

4.1.1 Geoelectric Units

The geoelectric sections (Figures 3a & b) show the variations of resistivity and thickness values of layers within the depth penetrated in the study area. Three subsurface layers were revealed: Lateritic Topsoil, Clayey-sand and presumed Fresh basement.

Topsoil

The topsoil is relatively thin across the study area with an average resistivity and thickness values of 280Ωm and.2.3m respectively.

Clayey-sand

Clayey-sand was encountered across the area with average resistivity and thickness values of 32Ωm and 7.3m respectively.

Basement

The basement is the fresh bedrock and is the last layer. It is relatively shallow in the study area, it was encountered in all the locations and the average resistivity and depth values to the top of basement are 674Ωmand 10m respectively.

Overburden

The overburden in assumed to include all materials above the presumably fresh basement. The depth to the bedrock varies from 6.3 to 13.5m and the average depth to the bedrock is 10m (Table 1 and Figure 3a & b). Overburden thickness was established in all locations and the average resistivity and thickness values are 156Ωm and 10m.The overburden materials constitutes the aquiferous units within the study area. The unit is porous, permeable and vulnerable to both leachate contamination and migration.

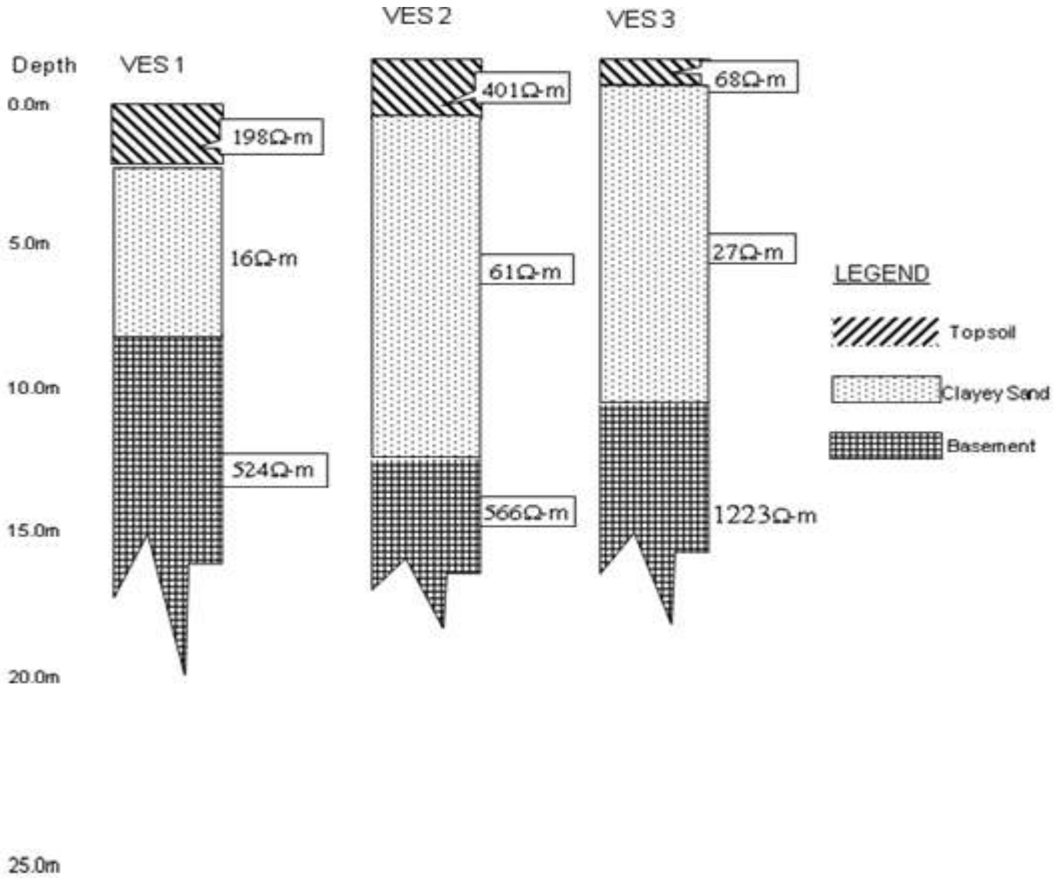


Fig. 3 a. Geoelectric Section of the study area

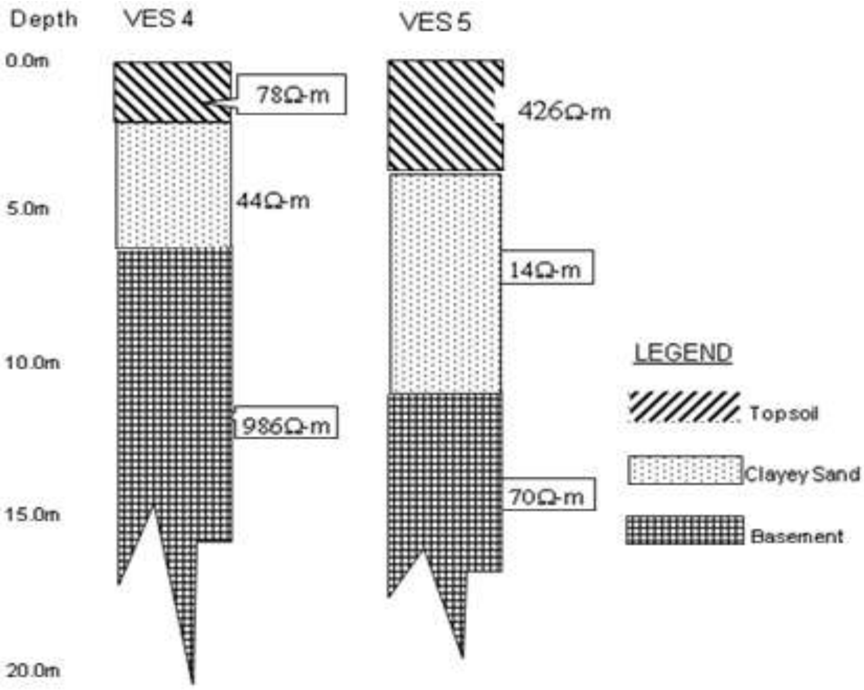


Fig. 3b. Geoelectric section of the study area

4.2 Horizontal Profiling

Result of the profile carried out is presented in the section below. The traverse is 100meters long. Three continuous subsurface lithologic units namely; Lateritic topsoil (blue), clayey-sand (green) and fresh basement (reddish purple) were established by the profile section. The results are presented in form of field, theoretical data and 2-D resistivity structures (Figure 4a, b & c). The 2-D resistivity plot revealed a relatively thin overburden and shallow basement across the study area.

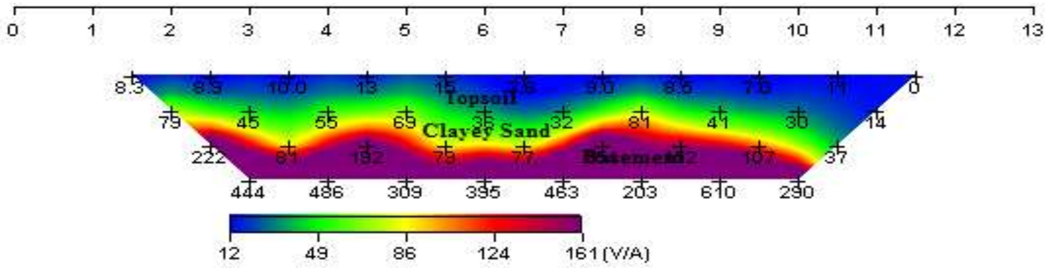


Fig. 4a: Field Data Pseudosection

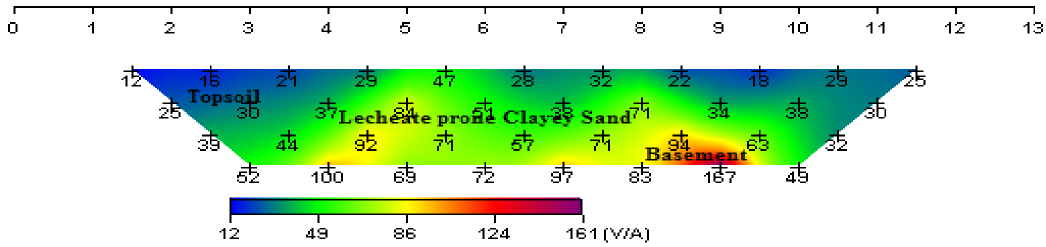


Fig. 4b: Theoretical Data Pseudosection

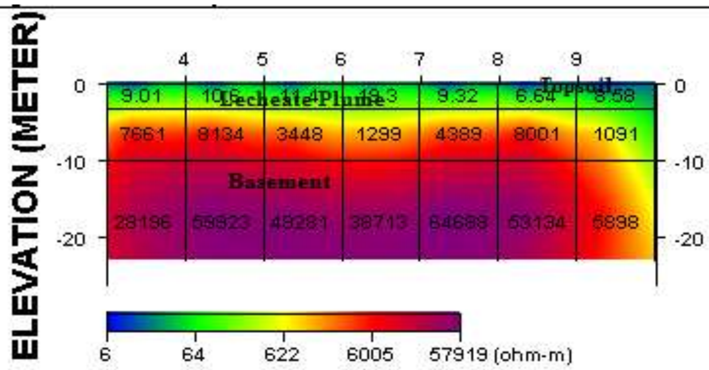


Fig. 4c: 2-D Resistivity Structure

V. DISCUSSION

The top soils are generally thin (within 0.8 – 3.8 m, with the average of 2.3m) in most parts and the average apparent resistivity value is 280 Ω-m while the clayey sand layers are relatively thick (within 4.0 – 11.0 m, with an average of 7.3m). The clayey sand average apparent resistivity value is very low (32Ω-m) across the study area. The combination of the top soil and clayey sand zones constitute the overburden units within the study area with an average thickness of 10m.

The overburden materials also constitute the aquiferous units within the study area. The aquiferous units (clayey sand in particular) are porous, vulnerable, and good paths for leachate migration. The resistivity values within the clayey sand layers are relatively low (14.0 – 61.0 Ω-m) which suggest leachate intrusion, while impervious basement resistivity values relatively high due to their crystalline nature.

VI. RECOMMENDATIONS

Detail and extensive geophysical studies should be conducted to locate a less vulnerable site for the dumpsite and arrangement should be made to relocation the existing site to a more appropriate location with higher protective capacity for groundwater.

Proper attention should be paid to both the construction and the practices of the dumpsite management.

VII. CONCLUSION

The existing dumpsite in ABUAD is vulnerable and leachate from the dump has impact on groundwater occurrence within its vicinity

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