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Groundwater Potential Evaluation And Vulnerability Of Igbatoro And Environs, Southwest Nigeria

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Abstract: ***Groundwater potential evaluation and vulnerability of Igbatoro and environs was conducted using primary and secondary data. Primary data were acquired on the field (geophysical data) while the secondary data were sorted from existing records. Resistivity Sounding was adopted using soil resistivity meter (R-50). Sounding was adopted for resolving resistivity variation with depth. Four geo-electric layers were delineated from the sounding curves namely; lateritic-topsoil, clayey-sand, fractured basement, and basement. The average overburden thickness and resistivity value in the area is 5.1m and 103Ω-m respectively. Both the overburden materials and the fractured basement constitute the aquiferous units in the study area and are highly vulnerable to contamination by leachate plumes from the nearby dumpsite though some fracture units are confined and less vulnerable. The aquiferous units are good paths for leachate migration, which was further enhanced by surface erosion.***

Keywords aquiferous units, leachate plume, vulnerability and leachate migration

I. INTRODUCTION

Igbatoro, a town in Ondo state, southwestern Nigeria, is an agrarian community located at the eastern edge of Akure close to the main dumpsite (Fig. 1). The community undoubtedly need constant supply of potable water for both domestic and commercial activities; hence, the need for a sustainable water supply network cannot be overemphasized. The basement nature of the terrain and its proximity to Akure main dumpsite poses a great challenge to a safe and adequate supply of potable water in this community. Presently, the community depends on rainwater, surface water, boreholes and shallow hand dug wells for its water supplies, however the daily demand for potable water is yet to be met. Most of the inhabitants in this area still have difficulties in getting water to meet their basic requirement.

The aim of the study is to investigate the potential and vulnerability of groundwater in this environment.

II. LOCATION AND GEOLOGY OF THE STUDY AREA

Igbatoro is in southwestern Nigeria, at the eastern edge of Akure. The terrain in the study area is moderately undulating, with topographic elevation ranging from 200m to 360m above sea level.

The area is situated within the tropical rain forest region, with a climate characterized by dry and wet seasons. Annual rainfall ranges between 100 and 1500 mm, with average wet days of about 100. The annual temperature varies between 18^0C to 34^0C.

The geology lies within the basement complex of south-western Nigeria and is characterized by migmatite gneiss and pelitic schist with quartzite layers (Rahaman 1976), (Fig. 2).

The Nigeria Basement Complex extends westwards as far as Dahomey-Togo-Ghana region to the east and south. The Mesozoic-recent sediments of the Dahomey and Niger basins cover the basement complex. The study area is underlain by granite gneiss, which constitutes part of the migmatite-Gneiss-Quartzite complex of the Basement Complex of southwestern

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Nigeria (Rahaman, 1989). The local rock units consist of Migmatite-Gneiss, Older Granites and Charnockites . The rock types are grey in colour, varies in grain size between 2 and 3.5mm and marked by irregular streaks. The dominant minerals in the rock type are the leucocratic minerals chiefly quartz and feldspar, while ferromagnesian minerals, mainly biotite, are present in lesser amount.

Groundwater availability and vulnerability in Igbatoro is dependent on the amount of precipitation and the recharged area of the aquifer. The extent of weathering within the basement and the presence of fractures within the basement rocks. Consequently, groundwater availability and vulnerability investigation in Igbatoro was directed towards the overburden, weathered basement and fracture zones underlying weathered basement with fairly porous and deep network of joints and fractures or fissures.

The quantity of water that can be accommodated underground depends on the porosity and permeability of the subsurface strata.

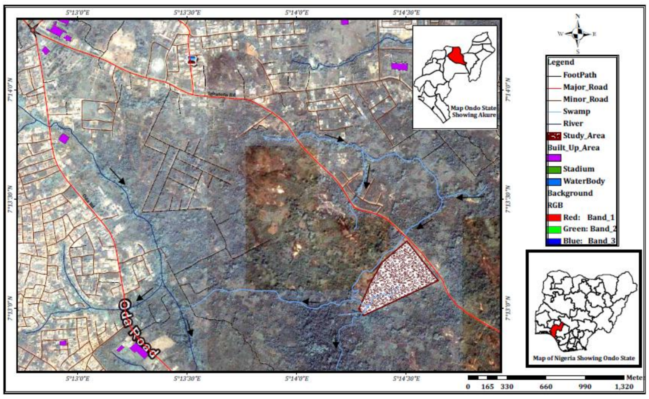

Figure 1: Map of some Part of Akure Highlighting the Study Area

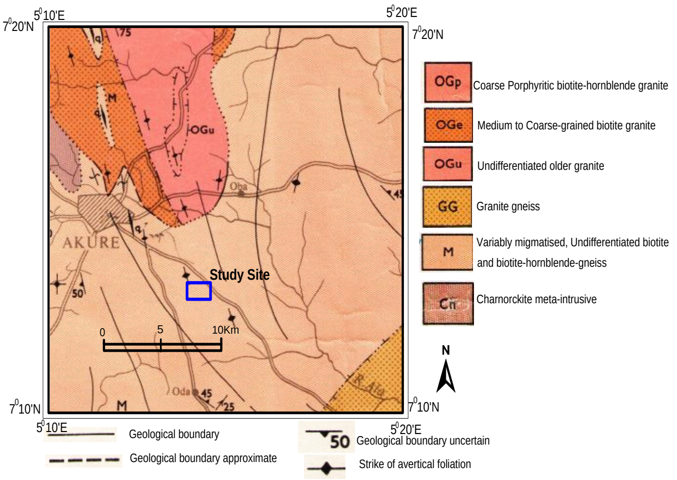

Figure 2: Geological Map of Akure Showing the Study Area (Adapted from NGSA)

III. MATERIALS AND METHOD

An indirect and non-intrusive Geophysical survey of Igbatoro adopting resistivity sounding was conducted using RDD3 soil resistivity meter. Seventeen vertical electrical soundings were conducted across the study area along eight different traverses to resolve vertical resistivity variation with depth and deduce the various geo-electric layers and their thicknesses, aquiferous units and their vulnerability to contamination that may result from leachate (Fig. 3 & 4).

Sounding assisted in understanding resistivity variation with depth within the study area. The adopted sounding method enabled the resolution of the various subsurface units, their hydrogeological significance, protective capacity and or vulnerability of the units to contamination. The primary data obtained from the field is Vertical Electrical Soundings data. Resistivity sounding was adopted for resolving resistivity variation with depth, thus sounding helped in delineating the various subsurface lithological units, hydrogeological significance and the protective capacity and vulnerability of the subsurface layers to pollution. The local geology of the area was studied and the existing hydrogeology pattern was observed.

IV. RESULTS

The field data obtained from VES were interpreted quantitatively by partial curve matching and computer iteration techniques. Typical samples of some of the geoelectric curves obtained from the study are presented below (Fig. 3).

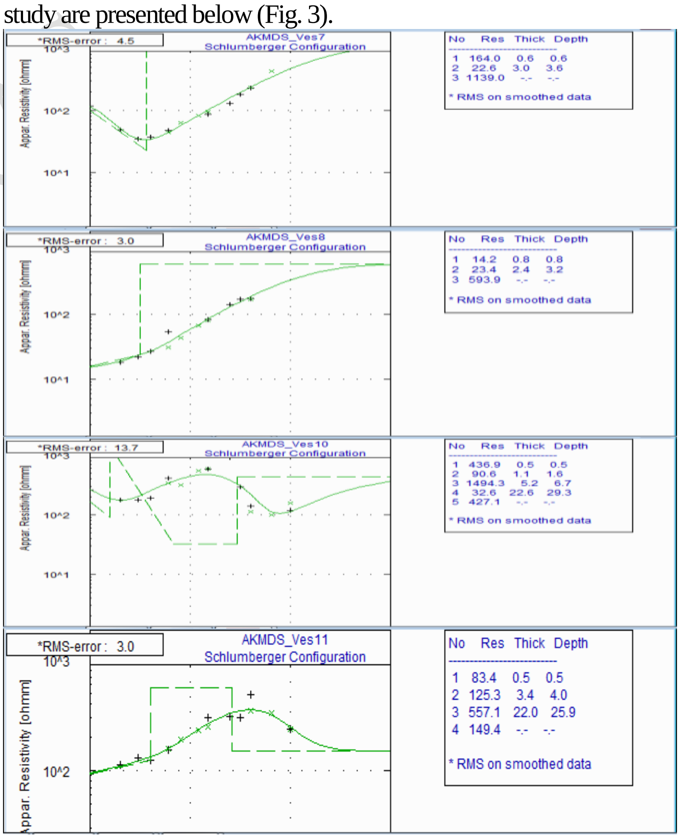

Figure 3: Typical Depth Sounding Curves of the Study Area

	VES POINT CURVE TYPE		1 A	2 KH	3 A	4 H	5 KH	6 HA	7 HA	8 A	9 HA
LITHOLOGY	Lateritic-Topsoil	Top	0	0	0	0	0	0	0	0	0
		Base	3	2	2	1	1	2	4	3	2
		Ωm	454	411	343	765	79	226	164	23	155
	Clayey-Sand	Top	3	2	-	-	-	2	-	-	2
		Base	5	6	-	-	-	7	-	-	8
		Ωm	170	153	-	-	-	41	-	-	100
	Basement	Top	5	6	2	1	1	7	4	3	8
		Base	-	20	-	10	4	-	-	-	-
		Ωm	2376	3304	2076	787	744	4049	1139	594	488
	Fractured Basement	Top	-	20	-	10	4	-	-	-	-
		Base	-	28	-	23	22	-	-	-	-
		Ωm	-	644	-	200	275	-	-	-	-
	Basement	Top	-	28	-	23	23	-	-	-	-
		Base	-	37	-	-	-	-	-	-	-
		Ωm	-	784	-	478	1495	-	-	-	-
	Fractured Basement	Top	-	37	-	-	-	-	-	-	-
		Ωm	-		-	-	-	-	-	-	-

Table 1a: Correlation of the Various Subsurface Layers across the Study Area

	VES POINT CURVE TYPE		10 KHK	11 K	12 HA	13 A	14 A	15 HA	16 KHA	17 KH
LITHOLOGY	Lateritic-Topsoil	Top	0	0	0	0	0	0	0	0
		Base	1	1	1	7	3	4	1	1
		Ωm	437	83	103	12	5	18	61	15
	Clayey-Sand	Top	1	1	1	7	3	4	1	-
		Base	2	4	8	14	8	6	7	-
		Ωm	91	125	86	130	130	54	122	-
	Basement	Top	2	4	8	14	8	6	7	1
		Base	7	26	-	-	-	-	-	5
		Ωm	1494	557	2280	729	1582	5678	4097	976
	Fractured Basement	Top	7	26	-	-	-	-	–	5
		Base	29	-	-	-	-	-	-	18
		Ωm	33	149	-	-	-	-	-	111
	Basement	Top	29	-	-	-	-	-	-	18
		Base	-	-	-	-	-	-	-	-
		Ωm	427	-	-	-	-	-	-	1440
	Fractured Basement	Top	-	-	-	-	-	-	-	-
		Base	-	-	-	-	-	-	-	-
		Ωm	-	-	-	-	-	-	–	-
	Basement	Top								
		Ωm								

Table 1b: Correlation of the Various Subsurface Layers across the Study Area

The correlation table presents the summary of the different inferred subsurface layers as revealed by the sounding curves.

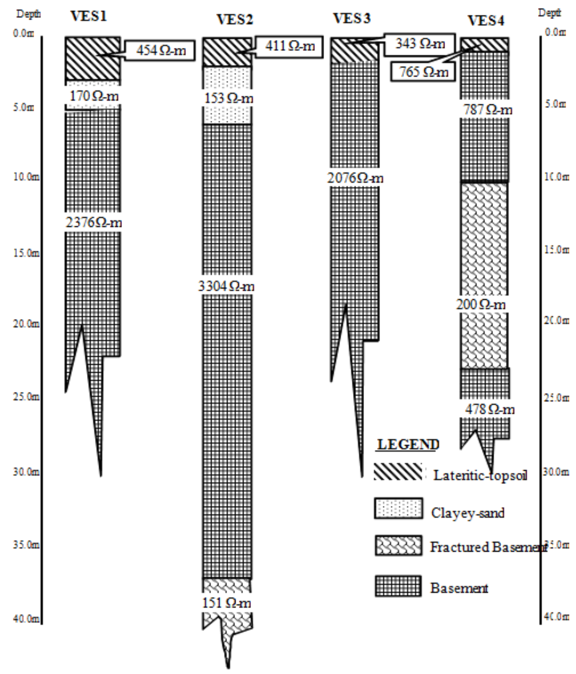

Figure 4: Typical Geoelectric Section of the study area

The geoelectric sections correlate the various vertical subsurface layers revealed by the sounding curves of the study area.

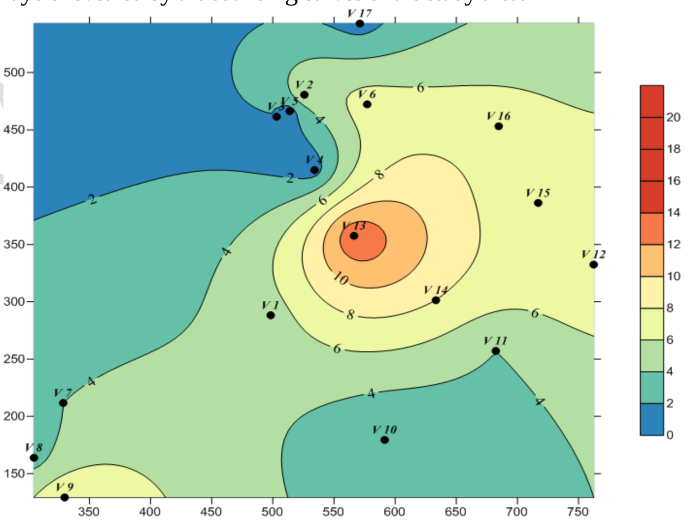

Figure 5: Isopach Map of the Study Area

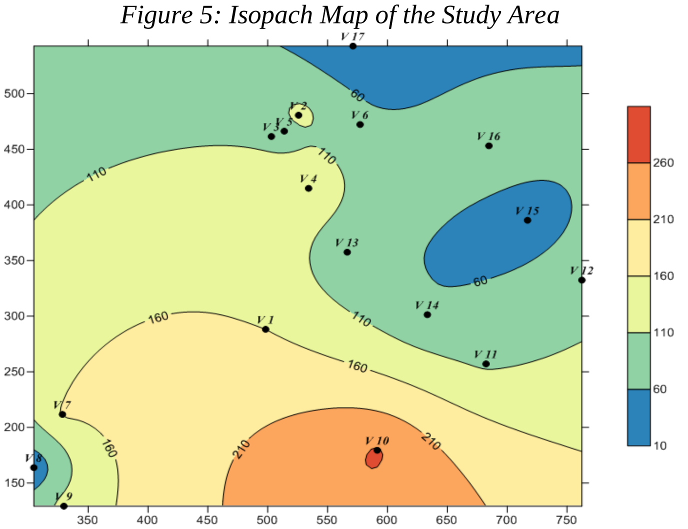

Figure 6: Overburden Isoresistivity Map of the Study Area

V. DISCUSSIONS

The interpretation of the depth sounding curves revealed six curve types from the study area namely; A, H, HA, KH, KHA, and KHK (Fig. 3.). Four geo-electric layers were delineated from the sounding curves namely; lateritic-topsoil, clayey-sand, fractured basement, and basement (Fig. 4).

A correlation table was generated by comparing different geo-electric layers revealed by the sounding curves (Table 1a & b). The top soil and sandy layers constitute the overburden materials with an average thickness of 5.1m. Resistivity values of the overburden materials are low with an average of 103Ω-m.

Generally, areas with thick overburden and low percentage of clay in which intergranular flow is dominant are known to have high groundwater potential particularly in basement complex terrain (Olorunfemi and Oloruniwo, 1985). Basement is relatively shallow in this area with an average depth-to-basement of 5.1 m. The rock in the study area is partially fractured as revealed by depth sounding curves analysis. The combination of the overburden materials and the fractured basement constitute the aquiferous layers (Table 1a & b).

Based on the depth sounding curves analysis and the resulting correlation table (Fig. 3 & Table 1a &b), geoelectric sections were generated for the various soundings for further correlation and enhanced pictorial view of the geo-electric layers across the study area (Fig. 4).

The overburden thicknesses of the various sounding points were used to generate an isopach map (Fig. 5). The isopach map revealed that the overburden material is thickest around the eastern end of the study (ranging from 6 – 12m) and is relatively very thin toward the western end of the study area (ranging from 2 - 4m). The overburden material is averagely thin toward the northern and southern end of the study (ranging from 2 - 4m), (Fig. 5).

The isopach map (Fig. 5), revealed that basement is relatively shallow in the western and southern end of the study area and the overburden material in these sections of the study have little hydrogeologic significance. However, basement deepens toward the eastern end of the area and the relatively thick overburden material in this section has moderate potential for groundwater.

Observed thickness and nature of the weathered layer are important parameters in the groundwater potential evaluation of a basement complex terrain (Clerk, 1985; Bala and Ike, 2001). Horizon is regarded as a significant water-bearing layer (Bala and Ike 2001) if significantly thick and the resistivity parameters suggest saturated conditions.

From the depth sounding curves analysis and the resulting correlation table (Fig. 3 & Table 1a & b), isoresistivity map of the overburden material was generated (Fig. 6). The isoresistivity map showed that the overburden materials generally have relatively low resistivity values (ranging from 60 - 210 Ω-m). The eastern end of the study has the lowest value (60 Ω-m) while the southern end has the highest value (210 Ω-m).

Areas with relatively high resistivity value (180 Ω-m and above) are suggestive of non-porous, impermeable crystalline rocks with no hydrogeologic significance (except fractured). Very little or no water percolation is experienced in such areas hence they are not vulnerable to contamination. On the other hand, areas with relatively low resistivity values (60-180 Ω-m) are suggestive of clayey-sand, porous, permeable aquiferous materials with moderate groundwater potential but they are prone to contamination arising from leachate infiltration.

VI. CONCLUSION

The study revealed that the area has moderate groundwater potential resulting from the combination of the overburden materials and the fractured units. Some of the fractured units are confined and not vulnerable to contaminations from the surface, however, some fractured units are not confined and as such, are vulnerable to contamination.

REFERENCES

[1] Bala AE, Ike EC (2001). The aquifer of the crystalline basement rocks In Gusau area, NW Nigeria. J. Min. Geol. 37(2): 177-184.

[2] Clerk L (1985). Groundwater Abstraction from Basement Complex Areas of Africa. J. Eng. Geol., London 18: 25-34.

[3] Olorunfemi MO, Olorunniwo MA (1985). Parameters and aquifer characteristics of some parts of SW. Nigeria Geologic Applica E. Hydrogeological, XX Part 1, pp. 99-109.

[4] Rahaman MA (1989). Review of the basement geology of SW Nigeria: In Geology of Nigeria (Kogbe CA Ed.). Elizabeth Publishing.Co. Nigeria. pp. 41-58.