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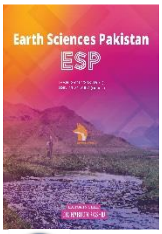

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RESEARCH ARTICLE

HYDROGEOPHYSICAL INVESTIGATION USING ELECTRICAL RESISTIVITY METHOD IN TANKE ILORIN, KWARA STATE

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ABSTRACT

Geophysical investigation using electrical sounding technique was carried out in Tanke community Ilorin, in order to characterize or explore ground water potential. The top soil resistivity values vary from 68.1Ωm to 65.1Ωm and thickness varying between 1.7m to 9.9m. The second layer resistivity values varies from 32.9Ωm to 651.1Ωm and the thickness vary from 2.9m to 12.7m.The third layer is the weathered basement with resistivity and thickness values varying between 22.6Ωm to 9562.6Ωm and 7.8m to 51.1m.The fourth layer is the partly weathered and fractured basement with resistivity and thickness values varying between 101Ωm to 2100Ωm and 80.1m to 124m while the fifth layer is apparently fresh basement whose resistivity values vary from 154.9Ωm to 7130Ωm with an infinite depth. The study further reveal VES 3, 4, and 5 as productive fractures within the weathered basement while other VES points are not productive.

KEYWORDS

Electrical Sounding Technique, Geophysical, Ves points, Groundwater.

1. INTRODUCTION

Groundwater refers to the water found in the pore spaces, crevices and rocks below the surface of the earth. It is usually extracted from the subsurface through a well or borehole drilled to the aquifer. An aquifer is a rock unit that will yield water in usable quantity to a well or spring (in geologic usage, "rock" includes unconsolidated sediments) (Ralph, 1987). An aquifer can also be defined as a saturated water bearing stratum that is capable of holding, transmitting and yield sufficient water in underground to well (Sharma and Sharma, 2007). According to a study, a unit of rock or an unconsolidated deposit is called an aquifer when it is capable of producing a usable quantity of water (Alabi et al., 2010). An aquifer should supply sustainable quantity of water to the borehole.

Geophysical investigation of the interior of the earth involve taking measurements at or near the earth's surface that are influenced by the internal distribution of physical properties and analysis of these measurements can reveal how the physical properties of the earth's interior vary vertically and laterally (Keary et al., 2002). Since groundwater cannot be easily located, a variety of scientific techniques are needed to provide information concerning its occurrence and location. The use of geophysical survey provide tool for both ground water resources, mapping and for water quality evaluation. Many of these geophysical techniques have been applied to ground water with some showing more success than others. The method includes gravity, magnetic, seismic, electrical and electromagnetic method (Reynolds and Vincent, 1997). The methods that have proved particularly effective to groundwater studies (characterization) are the electrical and electromagnetic.

This is because many of the geological formation properties that are critical to hydrogeology such as porosity and permeability of rocks can be correlated with electrical conductivity signatures. Many of these geophysical techniques have subsequently been used for ground water characterization but once again the greatest success has been shown with the electrical and electromagnetic methods (Eke and Igbokwe, 2011). But this project will basically made use of electrical resistivity method in the characterization of the study area, and essence determine the subsurface geological structure in which the water exist, such as fracture joint etc (Araff, 2012).

A lot of geophysical and hydro geophysical work has been done across the length and breadth of the world in the field of ground water exploration. These methods are regularly used to solve a wide variety of ground water problems. This paper therefore seeks to contribute to the effort which was carried out by other researchers, government and other non-government organization (NGO's) in the pursuit of helping in reducing water crisis in the study area. Similarly, the vertical electrical sounding will be used in profiling and studying the variations of resistivity with depth respectively in order to locate ground water bearing zones.

1.1 Geology of Nigeria

Geology of Nigeria lies approximately between latitudes 4^0N and 15^0N and latitudes 3^0E and 14^0E (Figure 1). The Geology of Nigeria is dominated and

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made up of two main rock types namely the basement complex and the sedimentary basins, which are equally dispersed. Other minor formations are the Volcanic Plateau and the river alluvium. In the basement complex terrain (comprising the West, North Central and the South East blocks). Rock types are predominantly of magmatic and granitic gneisses, quartzite, slightly migmatised to unmigmatised metasedimentary sedimentary schists and dioritic rocks (Rahaman, 1988).

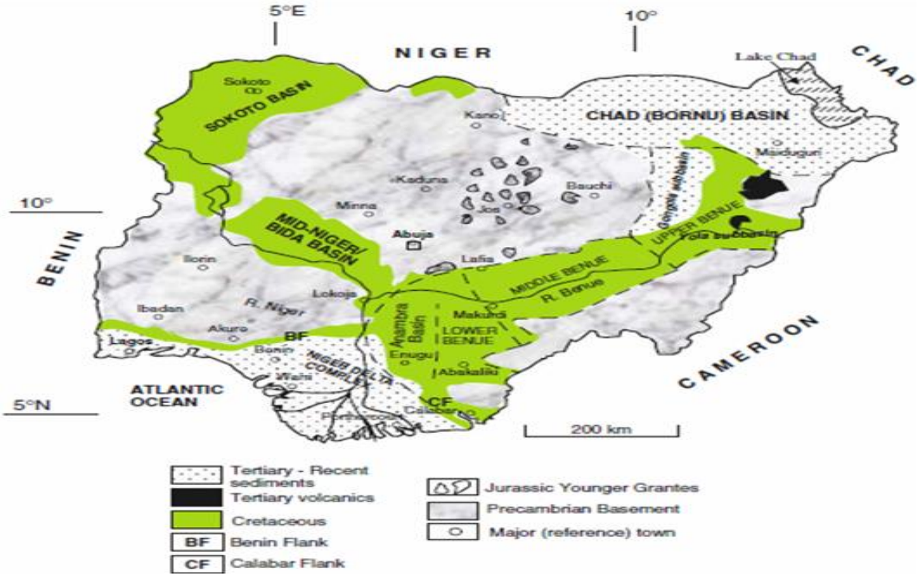


Figure 1: Geological Map of Nigeria (Obaje, 2009)

2. Location and Geology of The Study Area

The study area (Figure 2) falls in the basement complex of North – central part of Nigeria, which is of Precambrian to Lower Paleozoic in age (Rahaman, 1976). This Precambrian crystalline basement complex consists of gneisses, migmatities, and metasediments (that is, schists quartzites and metavolcanics: and Pan-African (Older) granite and minor pegmatitic and aplitic intrusive rocks (Oluyide et al., 1998). According to some study, Ilorin is situated on the undifferentiated Precambrian basement complex rocks of granitic and metamorphic origin (Olasehinde et al., 1998). These rocks represent the deeper, fracture aquifer which is partly overlain by a shallow, porous aquifer, within the lateritic soil cover (Annor and Olasehinde, 1996). The rock units form part of the regional south - western highlands of Nigeria running NW-SE parallel to the River Niger.

The subsurface comprises the weathered, slightly weathered and fresh (fracture or unfractured) crystalline basement rocks. The oldest rocks in the area comprise gneiss complex whose principal member is biotite - hornblende gneiss with intercalated amphibolites. This underlies over half of the city. Other rock types are older granite mainly porphyritic granite, gneiss and granite-gneiss and quartz schist. The two main types of aquifer in this area are the weathered basement and jointed/fractured basement aquifers with the latter usually occurring below the former. The aquifers are localized and localized and disconnected but occur essentially as unconfined to semi-confined under water table condition, although the crystalline nature of the basement rocks preclude development of the porosity and permeability necessary for good groundwater occurrence.

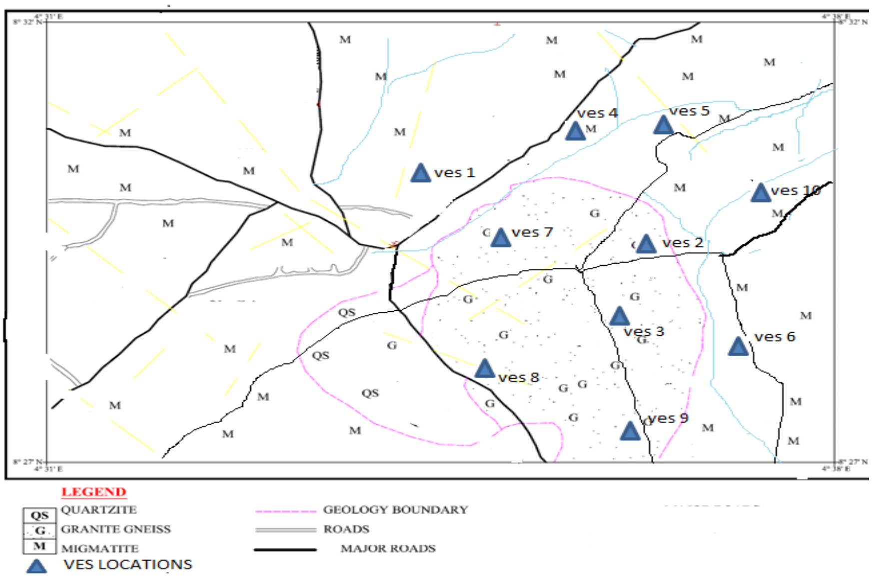


Figure 2: Geological Map of the study area

3. Materials and Methods

The vertical electrical sounding (VES) by adopting the Schlumberger method was carried out at preferred points in the study area (Figure 2) (Zhordy et al., 1974; Patra and Nath, 1998). In this depth sounding mode, a series of measurements were made with increasing separation between the electrodes about the midpoint. The electrode spacing (AB/2) varied from 1 to between 100 m depending on field condition. A total of ten VES positions were occupied. The ABEM SAS 1000 portable terrameter having an inbuilt booster was used for the data acquisition. It could compute and display the apparent resistivity of the subsurface layer with the input data of the electrode configuration, the current and potential electrode separation. The observed field data was used to produce depth sounding curve (Figure 4 and 5). Quantitative interpretation of the data was done with both curve matching and computer assisted iterative methods using the Win resist software. The computer modeling utilized the partial curve matching results (layer resistivity and thickness) as starting models. The geologic interpretation of the VES results was aided by the lithologic logs from the same boreholes in the area. The results obtained from the computer modeling are presented in table 1.

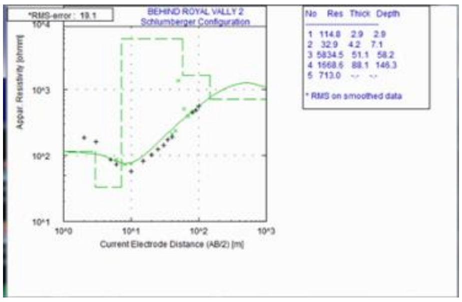
4. Results and Discussion

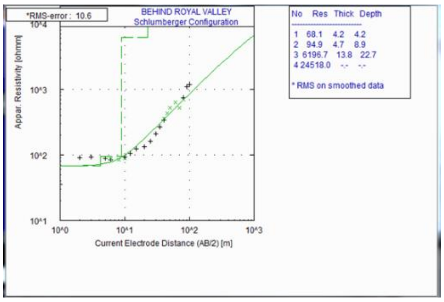
Table 1 shows the geo-electric layer parameters deduced from computer iteration and modeling of VES curves in the study area. The model curve type ranges from five, four and three geologic layers, HK, AAK, KQ, HA, AK, KQ curve types. (Figure 3 and 4). The modeling or iteration of ten (10) stations has been used to derive the geoelectric sections for various profiles. The geologic sequence beneath the study area is composed of top soil, lateritic clay, weathered basement, partly fractured basement and fresh basement. The top soil is composed basically of sand that has been eroded. The resistivity values vary from 68.1Ωm to 65.1Ωm and thickness varying between 1.7m to 9.9m. These values can be attributed to variation in the amount of moisture in the soil. The second layer is composed of sand and clayey- lateritic soil with resistivity varying from 32.9Ωm to 651.1Ωm and the thickness vary from 2.9m to 12.7m. It is important to note from the geoelectric sections that VES 1, 2, 4, 5 and 6 are characterized with low resistivity values varying within 22.6Ωm to 79.4Ωm suggesting clayey – lateritic nature in the second layer.

These areas are made up of high moisture content. The third layer is the weathered basement with resistivity and thickness values varying between 22.6Ωm to 6196.7Ωm and 7.8m to 51.1m respectively. However, virtually all the VES has a higher resistivity with corresponding thicknesses but with the exception of VES 3, 4, and 5. The thickness of these three layers varies from 7.8m to 10.4m with resistivity varying from 22.9Ωm to 939Ωm. It is characterized by low resistivity and this infer occurrence of probable ground water potentials suitable for siting borehole. The fourth layer is the partly weathered and fractured basement with resistivity and thickness values varying between 101Ωm to 9562Ωm and 80.1m to 124m respectively. The fifth layer is apparently fresh basement whose resistivity values vary from 154.9Ωm to 7130Ωm with an infinite depth. The layer is extensive and thickest in VES 3 and thinnest in VES 7. However, the depth from the earth surface to the bedrock surface varies between 1.7m to 154.5m deepest at VES 3 and shallowest at VES 10.

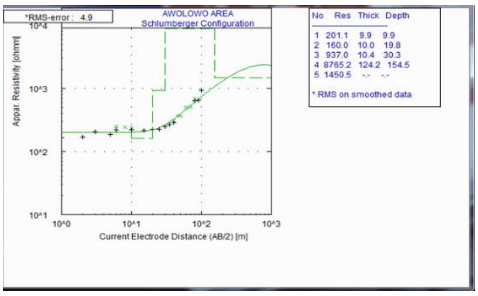
Table 1: The Interpretation of VES 1 to 10 locations

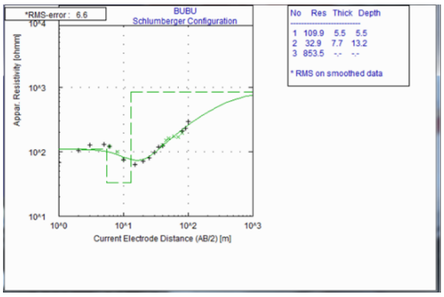
VES STATIONS	No of layers	Thickness (m)	Resistivity (Ω)	Depth (m)	Curve Type	Inferred Lithology
1	1	2.9	114.8	2.9	H	Top soil
	2	4.2	32.9	7.1		Lateritic clay
	3	51.1	5834.5	58.2		Basement rock
	4	88.1	1668.6	145.3		Weathered Rock
	5		7130			Fresh Basement
2	1	4.2	68.1	4.2	A	Top soil
	2	4.7	294.9	8.9		Lateritic clay
	3	13.8	6196.7	22.7		Basement rock
	4		2451.8			Fresh Basement
3	1	9.9	201.1	9.9	KH	Top soil
	2	10.0	160.0	19.9		Lateritic clay
	3	10.4	939.0	30.3		Basement rock
	4	124.2	8765.2	154.5		Fresh Basement
4	1	5.5	109.9	5.5	H	Top soil
	2	7.7	32.9	13.2		Lateritic clay
	3		853.5			Basement rock
5	1	3.2	614.9	3.2	HA	Top soil
	2	2.5	51.8	5.2		Lateritic clay
	3	7.8	22.6	13.0		Weathered Basement
	4		1724			Fresh Basement
6	1	2.9	263.2	2.9	HK	Top soil
	2	5.4	79.4	8.3		Lateritic clay
	3	29.9	2858.8	38.2		Weathered Basement
	4		735.8			Fresh Basement
7	1	5.6	302.2	5.6	A	Top soil
	2	12.7	726.3	12.7		Lateritic clay
	3	39.3	1340.3	52.0		Weathered Basement
	4	80.1	1447.0	132.1		Fractured Basement
	5		1283.9			Fresh basement
8	1	8.8	450.2	8.8	KH	Top soil
	2	9.0	127.5	17.8		Lateritic clay
	3	87.7	1341.5	105.5		Weathered basement
	4		621.0			Fresh basement
9	1	2.9	651.1	2.9	Q	Top soil
	2	6.7	428	9.6		Lateritic clay
	3	28.2	424.8	37.8		Weathered Basement
	4	82.4	101.4	120.1		Fractured Basement
	5		154.9			Fresh basement
10	1	1.7	510.4	1.7	H	Top soil
	2	6.1	112.1	7.8		Lateritic clay
	3	23.8	5935.7	31.6		Weathered Basement
	4	107.6	9562.6	139.2		Fractured Basement
	5		2100.1			Fresh basement



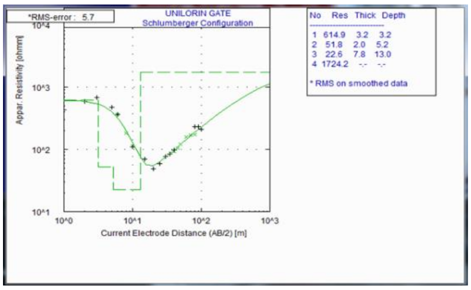


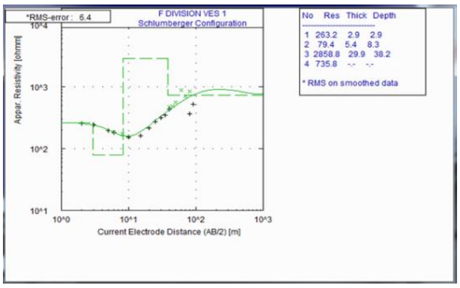
VES 1 **VES 2**





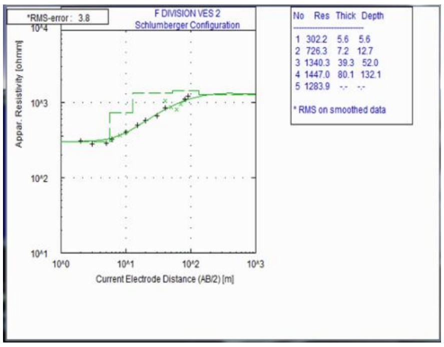
VES 3 **VES 4**

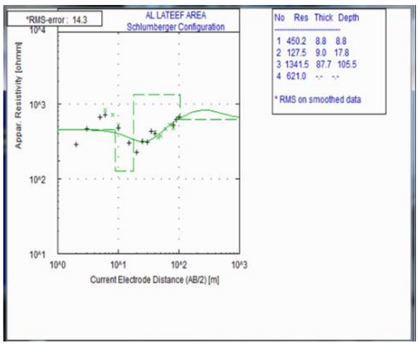




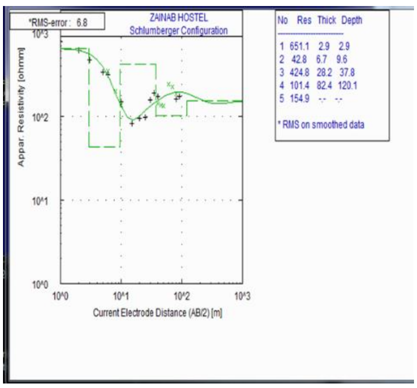
VES 5 **VES 6**

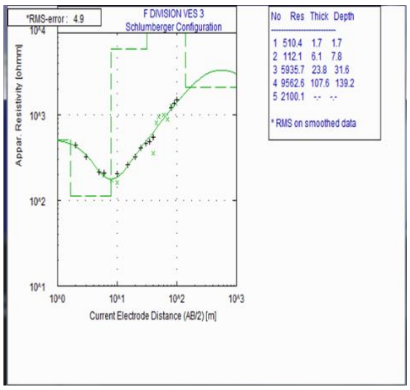
Figure 3: Electric section of VES 1 to VES 6





VES 7 **VES 8**





VES 9 **VES 10**

Figure 4: Electric section of VES 6 to VES 10

5. Conclusion

Geoelectrical investigation using electrical resistivity method was carried out around Tanke area, Kwara state, Nigeria. Four to five geologic layer are identified at the subsurface consisting of topsoil (sand), lateritic clay, slightly weathered and fresh basement rock. Based on the qualitative interpretation of VES data, it is concluded that VES stations 3, 4 and 5 revealed a slightly productive fracture within the basement and occurrence of water in both the overburden and weathered rock, while VES location 1, 2,6,7,8,9 and 10 revealed no fracture for aquifer because of high resistivity but there is overburden water. However, it is imperative to note that an extension of sounding between 150 - 250 meters might assist in locating a productive fracture zone.

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