ISSN XXXX XXXX © 2018 IJESC

Research Article Volume 8 Issue No.11

Evaluation of Groundwater Potential of Alagbaka Area of Akure Metropolis, Southwest Nigeria

O.O. Afolabi[1], I.E. Ogundipe[2], A.K. Ogundana[3]
Department of Geology
Afe Babalola University, Ado Ekiti, Nigeria

ABSTRACT:
Groundwater potential of Alagbaka quarters of Akure metropolis Southwest Nigeria was carried out using geophysical approach in order to delineate and classify the aquiferous zones of the area. The study area falls within the Migmatite Gneiss Complex of southwestern Nigeria and the major rock types are Chanokite and Granite. The study area was divided into five segments namely; NN, NW, SW, SE and NE. An average of four VES was conducted in each of the segment thereby giving a total of twenty three (23) Vertical electrical soundings using schlumberger array configuration. Based on the results of the VES, five different subsurface lithologic sequences were established and the curve types ranged from simple A, H, HA, HK, KH to complex KHK. The overburden materials and the fractured basement were characterised by relatively low resistivity values while the fresh basement were typified of high resistivity values. The combination of overburden materials with the fractured basement constitutes aquiferous units within the study area although the fractured basements were largely responsible for the groundwater potential of the area. The average thickness of the overburden materials varied from 3m in SE 4m in NW to 12m in NE while the average thickness of rock head to fresh basement varied from 10m in NE to 36m SW. The lithologic sequences of the five segmented areas consist of lateritic topsoil, clayey sand, weathered saprolite, fractured basement and fresh basement. The groundwater potential of the area from the north to south varied from very low or no hydrogeologic significance to moderate. The thickness of overburden materials and the fractured basement in the southern part of the study area constitutes the aquifer units with moderately enhanced groundwater yielding potential than the northern part. In general, the groundwater potential of the NN and NE segments are very low while the NW, SW and SE segments have moderate groundwater potential. Average overburden thickness in the study area is 13m while the average depth to the top of the fractured basement is 12m.

Introduction

Urbanisation and industrialisation in cities in some parts of the developing countries around the world have developed some attendant challenges resulting from geometric population growth against arithmetic infrastructural development and social amenities. The rapid urbanisation and industrialisation in Akure as a capital city was noticed and recognised by its selection as one of the mega cities in southwestern Nigeria. Alagbaka quarter of Akure metropolis is the seat of power of the Ondo State government and so it houses government agencies, parassatals and other private establishments.

The social amenities such as pipe bore water within this quarter are sometimes over stressed due to the high population density characterising this area on a daily basis. In order to meet the water demand by the inhabitants, groundwater is considered to be accessible and healthier complimentary source of freshwater since surface water with better abundance and proximity is facing a challenge of contamination and pollution with its direct interacting with atmosphere and man activities.

In addition to this, groundwater exploration in the basement aquifers poised a serious challenges resulting from complexity of rocks and minerals and their attendant heterogeneous grain size distribution. Groundwater aquifers are commonly located within the weathered overburden and fracture materials within the fresh rock. Therefore, sitting a well on this terrain for effective exploitation require a technical approach with better precision which geophysical method using electrical resistivity is commonly applied.

Electrical resistivity method has been used extensively in groundwater investigation especially in the basement complex terrains (Anhacusser, 1969; Grant and West, 1965; Olorunfemi and Olorunniwo, 1985; Olorunfemi, 1990; Olorunfemi and Olayinka, 1992). The method is commonly used in getting detailed information about hydrogeological settings for groundwater, geologic mapping, foundation investigation and environmental studies. Some of these include aquifer delineation, subsurface mapping, lithological boundary differentiation and geothermal exploration.

The study therefore aims at assessing the groundwater potential of the area with attention on the delineation of the fracture system, overburden thickness and lithological variation across the terrain.

The Study Area

The study area is underlain by the Migmatite-Gneiss Complex of South Western Nigeria. Several part of Africa is underlain by crystalline basement complex rocks. The major lithologies in Akure include Granite and charnokite. The granite is a member of the Older Granite suit occuping about 65% of the total area of Akure. Three principal petrographic varieties are recognized, the fine-grained biotite granite, medium to coarse grained, non-porphyritic biotite – hornblende granite and coarse – porphyritic biotite-hornblende granite. The classification is based largely on the textural characteristics. Also three main textural types of charnockitic rocks are also distinguished in Akure. These are the coarse-grained variety, massive fine grained and the gneissic fine-grained types.

Fig. 1: Area map of the study area

Materials and Methods

Geophysical resistivity data were acquired using R-50 D.C. Resistivity meter which contain both the transmitter unit, through which current was sent into the ground and the receiver unit, through which the resultant potential difference is recorded. The Schlumberger array was adopted. The electrode spread of AB/2 was varied from 1 to a maximum of 150 m. The expected depth of investigation was (D) = 0.125 L, where L = AB/2 and AB is the current electrode separation. Ground resistance (R) measurements were recorded with the R–50 D.C Resistivity meter. The electrical resistances obtained were multiplied by the corresponding geometric factor (k) for each electrode separation to obtain the apparent resistivity (r = kR) in ohm-meter.

The models obtained from the calculations above were used for computer iteration to obtain the true resistivity and thickness of the layers. Computer-generated curves were compared with corresponding field curves by using a computer program "Resist" version 1.0. The software was further used for both computer iteration and modelling. Computer iteration of between 1 - 29 were carried out to reduce errors to desired limit and to improve the goodness of fit. In all, a total of 23 VES locations, spreads over the study area (Figure 1) were covered. The acquired data were processed and interpreted in order to delineate the various subsurface layers, their geoelectric properties, thicknesses and aquiferous characteristics.

Results and Discussions

The study area consist of five different subsurface geoelectric units namely: lateritic topsoil, sand, weathered basement, fractured basement and basement. The average thickness and apparent resistivity values for the topsoil, sand, weathered basement and fractured basement in the NN segment are 1m and 947Ωm, 4m and 120 Ωm, 8m and 798 Ωm, 7m and 477 Ωm respectively (Table 1).

The average thickness and apparent resistivity values for the topsoil, sand, weathered basement and fractured basement in the NW segment are 1m and 540Ωm, 3m and 122 Ωm, 13m and 988 Ωm, 15m and 294 Ωm respectively (Table 1).

The average thickness and apparent resistivity values for the topsoil, sand, weathered basement and fractured basement in the NE segment are 3m and 772Ωm, 9m and 51 Ωm, 5m and 458 Ωm, 5m and 349 Ωm respectively (Table 1).

The average thickness and apparent resistivity values for the topsoil, sand and fractured basement in the SW segment are 1m and 500Ωm, 9m and 119 Ωm, 36m and 407 Ωm respectively (Table 1).

The average thickness and apparent resistivity values for the topsoil, sand, weathered basement and fractured basement in the SE segment are 1m and 70Ωm, 2m and 63Ωm, 11m and 374 Ωm, 6m and 95 Ωm respectively (Table 1).

The average thickness and apparent resistivity values for the topsoil, sand, weathered basement and fractured basement across the entire study area are 1m and 566Ωm, 5m and 95Ωm, 9m and 657 Ωm, 14m and 324 Ωm respectively (Table 1).

The average overburden thickness in the study area is 13m while the average depth to the top of the fractured basement is 12m.

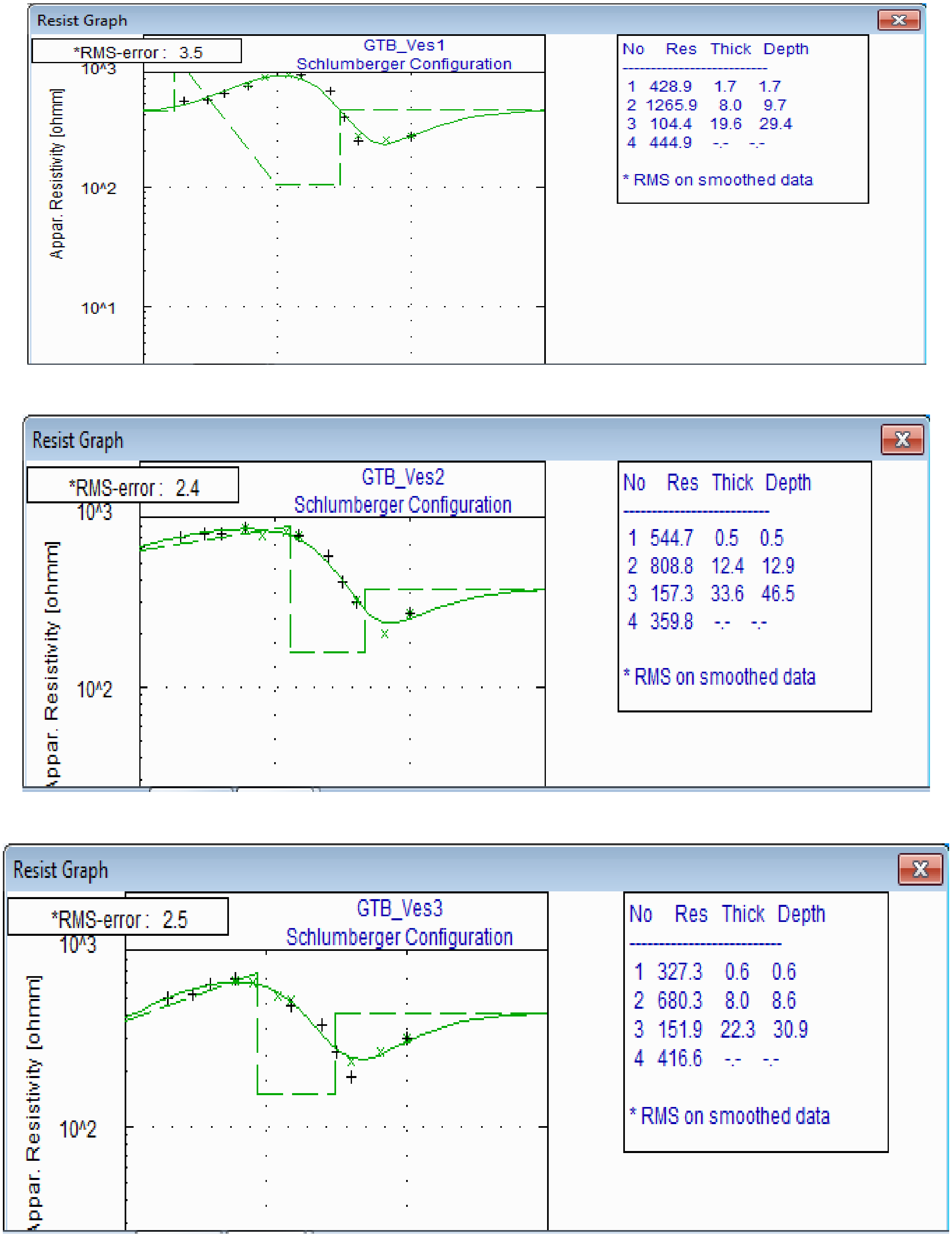

Fig. 2: Typical geoelectric curves of the study area

Table 1: Correlation

VES		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
CURVE		H	HA	HA	HK	HA	KH	KH	HK	HK	KHK	KH	KH		HA	HA	HA	HA	H	H	KH	HA	HA	HK
TOP SOIL	TOP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BASE	3.8	0.5	1	0.5	0.6	1.7	0.5	0.6	1.1	2	0.3	3.6	3.6	3.7	0.8	0.5	2.6	2.5	4.4	4.6	0.7	0.7	1
	TH	3.8	0.5	1	0.5	0.6	1.7	0.5	0.6	1.1	2	0.3	3.6	3.6	3.7	0.8	0.5	2.6	2.5	4.4	4.6	0.7	0.7	1
	Ωm	222	716	760	93	46	429	545	327	502	598	519	1012	1462	413	437	313	628	629	1278	809	434	1493	914
CLAYEY SAND	TOP	3.8	0.5	1	0.5	0.6					2								2.5	4.4	4.6	0.7	0.7	
	BASE	7.3	10.7	12.7	2.6	1.4					4.5								14.1	10.1	13.3	2.9	5.3	
	TH	3.6	10.2	11.7	2.1	0.8					2.5								11.6	5.7	8.8	2.2	4.7	
	Ωm	10	175	172	114	11					122								66	35	38	103	136	
WEATHERED SAPROLITE	TOP	7.3	10.7	12.7	2.6	1.4	1.7	0.5	0.6	1.1	4.5	0.3	3.6	3.6	3.7	0.8	0.5	2.6	14.1	10.1	13.3	2.9	5.3	1
	BASE				14.9	11.8	9.7	12.9	8.6	26.6	17.8	1.2	10.1	9.1	9	3.6	1.3	8.4	21.7	17.9	19.4	11.8	15.9	6.7
	TH				12.3	10.4	8	12.4	8	25.5	13.2	0.9	6.4	5.5	5.3	2.8	0.7	5.8	7.6	7.8	6.1	8.9	10.6	5.7
	Ωm	639	2664	3897	391	357	1266	809	680	866	553	1576	589	151	330	232	1004	967	169	222	147	223	260	1910
FRACTURED BASEMENTT	TOP				14.9	11.8	29.4	46.5	30.9	26.6	17.8	1.2					1.3							6.7
	BASE				19.2	21											6.6							
	TH				4.3	8.2											5.3							
	.Ωm				99	91	445	360	417	193	272	417					349							477
BASEMENT	TOP				19.2	21							10.1	9.1	9	3.6	6.6	8.4	21.7	17.9	19.4	11.8	15.9	
	BASE																							
	TH																							
	Ωm				127	155							1185	1652	1247	2493	7133	2376	1706	1210	1018	514	289	

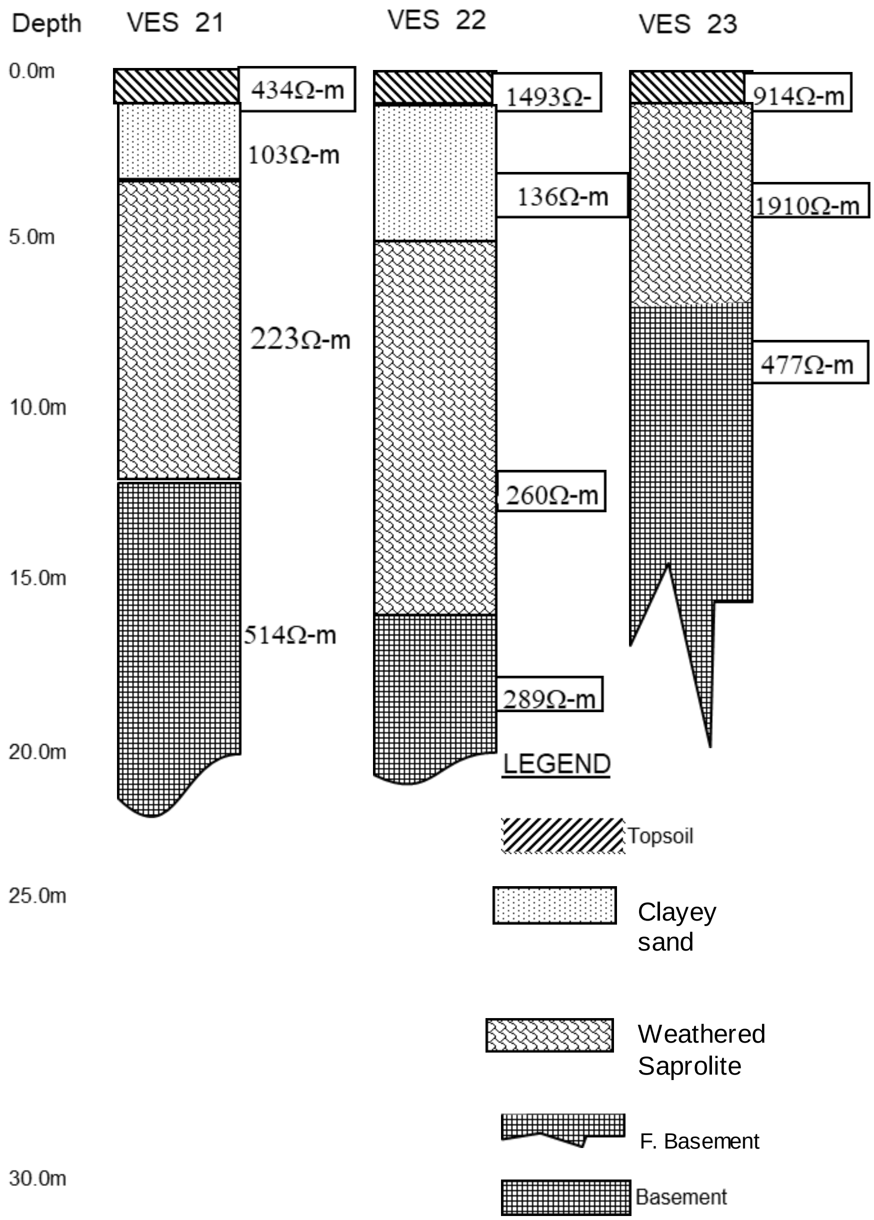

Fig. 3: Typical Geoelectric sections of the study area

Conclusion

In this study, the groundwater potential evaluation of Alagbaka, Akure, southwestern Nigeria was undertaken using 23 Schlumberger vertical electrical soundings (VES). The curve type varied from simple three-layer A and H-types to the complex HA, HK, KH, and KHK-types. The computer assisted sounding interpretation revealed subsurface sequence composing lateritic topsoil with limited hydrologic significance, clayey sand, weathered saprolite layer, fractured basement and the fresh basement.

The clayey sand, weathered and fractured layers constituted the aquifer unit in the area; the yield dependent on degree of the clay content. The higher the clay content, the lower the groundwater yield. The groundwater potential of the study area is considered to be low, little and moderate in the NN, NE and NW, SW, SE respectively. In general, groundwater potential rating across the area is considered to be moderate. An average depth of 30-40m is recommended for drilling in this area.

The results of this study have provided reliable information for an elaborate groundwater abstraction, planning and development. The need for detailed predrilling geophysical investigation for both domestic and industrial groundwater development cannot be overemphasised.

REFERENCES

[1] Anhaeusser, C. R, 1969. A Resappraisal of some aspects of Precambrian shield geology bull, Geo. Soc, Amer., Vol. 80, pp2175-2200.

[2] Grant, F. S., West, G. F, 1965. Interpretation theory in Applied Geophysics. New York, McGraw-Hill.

[3] Oladapo MI, Akintorinwa OJ (2007). Hydrogeophysical Study of Ogbese

[4] Southwestern, Nigeria. Global J. Pure and Applied Sci. 13(1): 55-61.

[5] Olorunfemi M. O.(1990): The Hydrogeological Implicationof Topographic Variation with Overburden Thickness in Basement Complex. Area of South Western Nigeria. Journal of Mining and Geology. Vol 26, No. 1.

[6] Olorunfemi M. D. & Olayinka A. I. (1992): Alteration of Geoelectric in Okene are and Implication for Borehole Sitting. Journal of Mining and Geology, pp. 403-411.

[7] Olorunfemi M. O. & Oloruniwo M. A. (1985): Geoelectric Parameters and Aquifer Characteristics of Some Part of South Western Nigeria. Journal of Mining and Geology.