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HYDROGEOPHYSICAL INVESTIGATION OF THE AREA AROUND ANGWARE IN JOS EAST PLATEAU STATE, NORTH CENTRAL NIGERIA.

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ABSTRACT

Hydrogeophysical investigation of the area around Angware and its environs was carried out. It is about 25km^{2}and lies between latitudes 10^{0}00'N and 9^{0}58'N and longitudes 9^{0}05'E and 9^{0}08'E. Schlumberger resistivity configuration method was used and interpreted with IP2Win 2.1 program. Geologically is underlain by Precambrian Basement complex(600±150Ma) and Mesozoic Younger Granites(130-150Ma).Computer aided results showed that the area is characterized by seven curve-types (A,H,Q,HA,QH,KA and QK) and 3,4 and 5 geo-electric layers with resistivity range and thickness of 100-692Ωm,1.4-51m; 15.7-1300Ωm,0.9-84m; and 72-504Ωm,0.9-36m respectively. The aquiferous zone revealed by the results is weathered/fractured Basement at a depth between 10-35m and resistivity range from 18-107Ωm, drilling depth of 20-45m is recommended for maximum yields.

KEY WORDS: Hydro Geophysical, Angware, Aquifer, Geo-Electric

INTRODUCTION

The nature of groundwater occurrence and distribution in typical Basement terrains is more complex due to the discontinuous pattern of crystalline aquifers. Successful groundwater development in such areas requires a quantitative knowledge of the hydrogeophysical parameters of the hydro-geologic units as well as the superficial materials overlying the crystalline rocks and the bedrock structures/relief, (Omosuyi *et al*, 2003; Olorunfemi *et al*, 1999 and Jeff, 2006). Ground water development in areas of crystalline rocks depends on the climatic factors such as temperature, rainfall, humidity, relief and vegetation (Offodile, 2002).

In this study a detailed hydrogeophysical investigation of Angware and environs was carried out with a view of determining the geo-electric parameters (layer resistivity, thickness and aquifer potentials) of the superficial/overburden materials overlying the bedrock, the subsurface structural disposition of the bedrock and their hydrogeologic characteristics. The nature of the regolith materials overlying the bed rock in the study area is very influential in defining the groundwater potentials of the area. Vertical electrical sounding conducted in about thirty points was interpreted to establish the control of hydrogeophysics on the occurrence and distribution of groundwater in Angware area.

Geology of the Study area

The study area is located in Jos East Local Government Area (L.G.A) of Plateau State. It lies between latitudes 10^0 00'N and 9^0 58'N and longitudes 9^0 05'E and 9^0 08'E.The study area is part of maijuju sheet. Geologically the study area is underlain by Precambrian Basement Complex (600±150ma) and later intrusion of Mesozoic Younger Granites (130-150ma) as given by various workers including McLeod et al (1971), McCurry (1989), and Turner (1989). The study area is situated between the Shere Hills and Jarawa hills constituted by Undifferentiated Migmatites, Hornblende Biotite, Granite Porphyry, Older Biotite Granite, Early Rhyolite and Aplitic Pegmatite. (Fig. 1)

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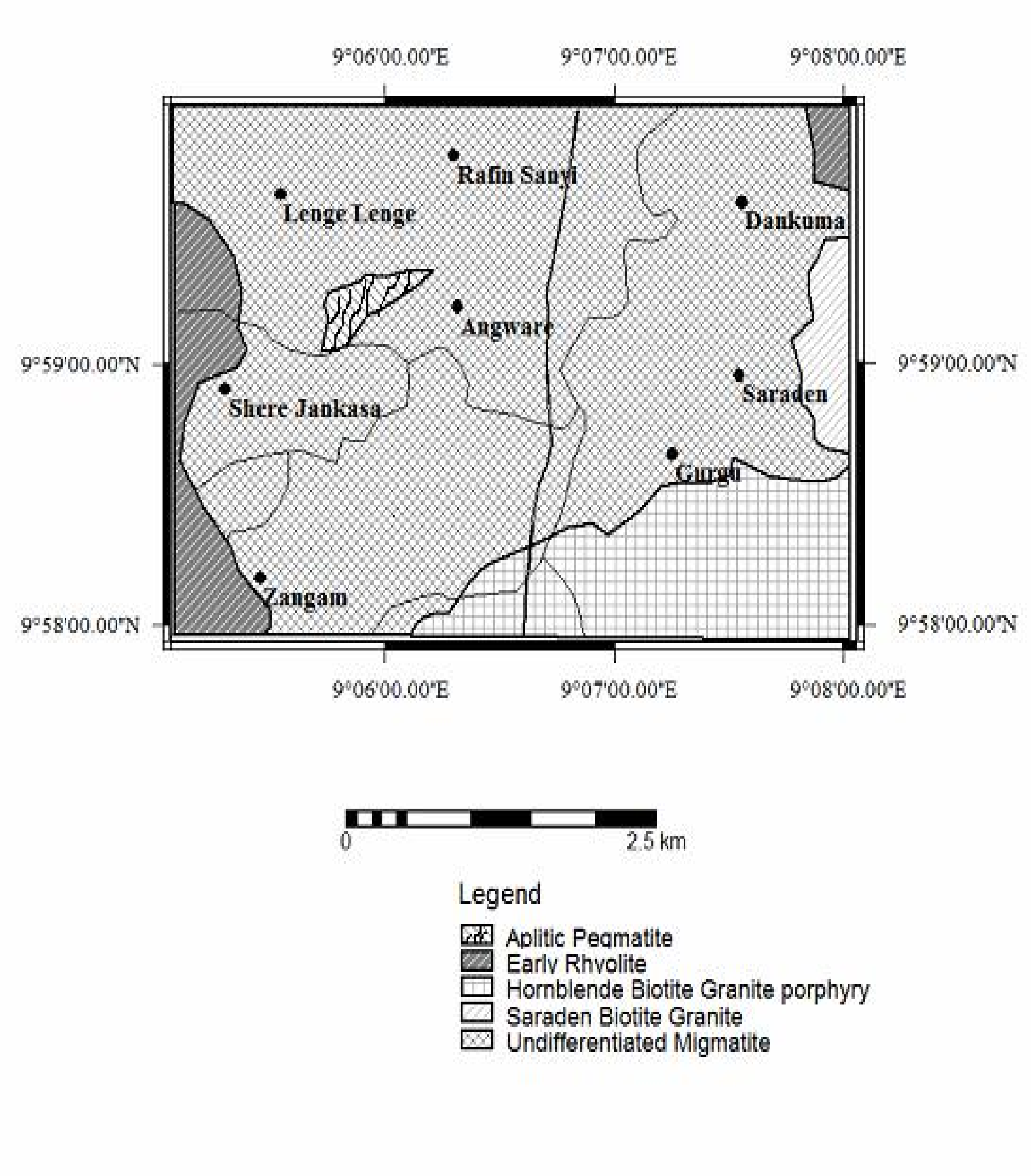

Figure 1. The Geological map of the study area

Materials and methods

The study was conducted in two phases; the geologic mapping preceded the hydrogeophysical investigation and was designed to collect and analyze rock samples with the aim of delineating areas with potentials of high yielding water wells. With the geology clearly established hydrogeophysical soundings were carried out at points well distributed to capture all the geologic Formations underlying the area. The main reason behind this approach was to bring out the geologic control on the hydrogeophysical parameters of significance in the groundwater occurrence and distribution. A total of twenty five probe points were investigated using campus allied ohmega resistivity, model number: 034CE to generate data on geoelectric layers, their resistivity, depths and thicknesses.(Fig 2) Plots of such data produced different type curves ranging from Q-type curve, K-type curve, H- type curve

A-type curve and combination of some of the type curves. The IPI2Win 2.1 version computer program was used to expedite the interpretation after manual partial curve matching. These data were interpreted to separate geologic units into aquiferous and non aquiferous.

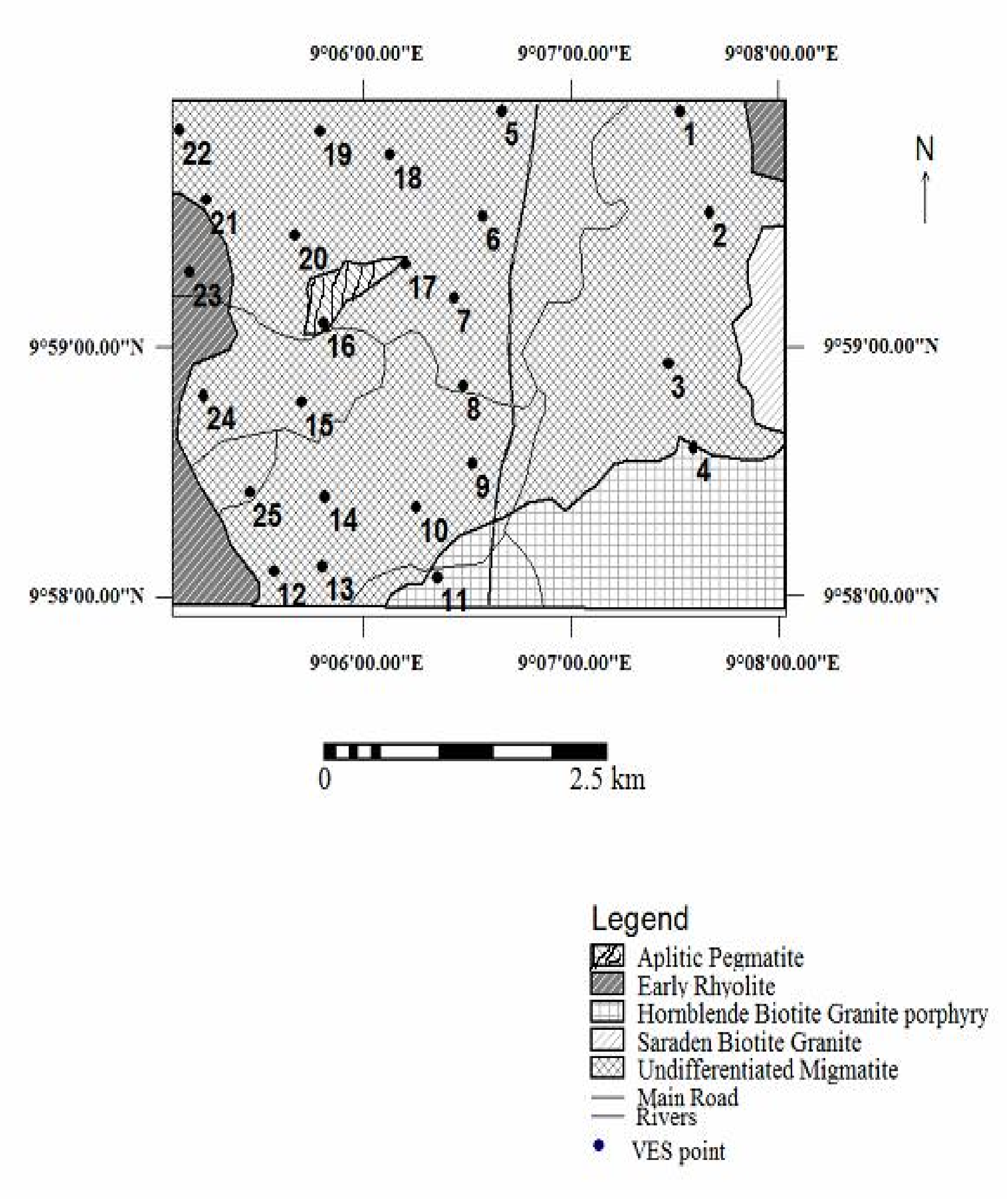

Figure 2. The map of the study area showing VES points

RESULTS

The twenty five vertical electric sounding (VES) data acquired were processed using the partial curve matching method and computer interpreted curves. The result is presented on table1. The geo-electric layers range from three to five and the characteristic VES curves are shown in figures 3.0-3.2

Table 1: Interpreted Results of Field Data

S/NO	VES	THICKNESS OF LAYERS(M)					RESISTIVITY OF LAYERS (OHM-M)					CURVE-TYPE	FITTING ERROR(%)
		h1	h2	h3	h4	h5	p1	p2	p3	p4	p5		
1	VES1	1.67	4.85	84.18	-	-	473	194.8	105.1	20.57	-	Q	0.752
2	VES2	1.31	3.89	5.589			15.03	73.54	15.7	175.23		A	0.546
3	VES3	0.89	1.08	17.61	-	-	40.22	8.34	112.8	131.83	-	HA	0.0674
4	VES4	1.35	15	-	-	-	586.1	246.4	397.5	-	-	H	0.0188
5	VES5	3.78	12.2	-	-	-	374.4	25.85	183.5	-	-	H	0.313
6	VES6	1.09	12.2	-	-	-	374.9	232.5	100	-	-	Q	0.0265
7	VES7	2.11	2.03	21.7	-	-	262.3	26.47	125.8	125.4		H	0.0623
8	VES8	0.31	18.8	-	-	-	115.2	51.5	144.8	-	-	H	0.215
9	VES9	1.86	10.1	10.3	-	-	1300	274	18.1	245.6		QH	0.106
10	VES10	1.75	8.72	14.06	-	-	924.5	181.7	41.11	745	-	H	0.111
11	VES11	1.73	5.59	13.96	26	-	89.98	40.57	20.46	73.15	-	QK	0.351
12	VES12	0.7	0.61	60.95	-	-	508.6	204.6	474.5	9.207	-	Q	0.302
13	VES13	0.96	7	68.25	-	-	990.6	538.2	19.6	42.77		Q	0.0986
14	VES14	2.12	4.91	11.46	27	-	1004	377.7	24.67	656.2	-	KA	1.46
15	VES15	1.15	8.87	13.85	-	-	724.9	202	14.7	476.3	-	QH	0.166
16	VES16	3.07	9.74	10.83	-	-	804.8	516.7	32.59	677	-	KA	0.179
17	VES17	0.61	7.52	55.03	-	-	2918	1373	107.6	654.9	-	QH	0.0992
18	VES18	1.06	6.84	15.67	-	-	403.6	151.8	62.83	692.8	-	H	0.454
19	VES19	1.55	4.81	-	-	-	692.4	498.9	248.2	-		Q	0.0749
20	VES20	2.55	38.1	-	-	-	384.2	132.9	205.5	-	-	H	0.0716
21	VES21	0.9	4.01	6.55	15	36	504.1	272.4	107	72.4	201	QK	1.3
22	VES22	1.12	8.92	65.8	-	-	687.3	346.7	215.7	69.08	-	Q	0.0911
23	VES23	1.93	51.1	-	-	-	314.9	78.94	143.3	-	-	H	0.097
24	VES24	0.58	9.09	76.61			668.9	353.2	199.7	10.06	-	Q	0.069
25	VES25	0.97	1.84	-	-	-	306.6	307.9	204.1	-	-	Q	0.0253
Mean		1.48	10.39	22.10	2.72	1.44	618.74	268.42	133.00	195.10	8.04		0.282

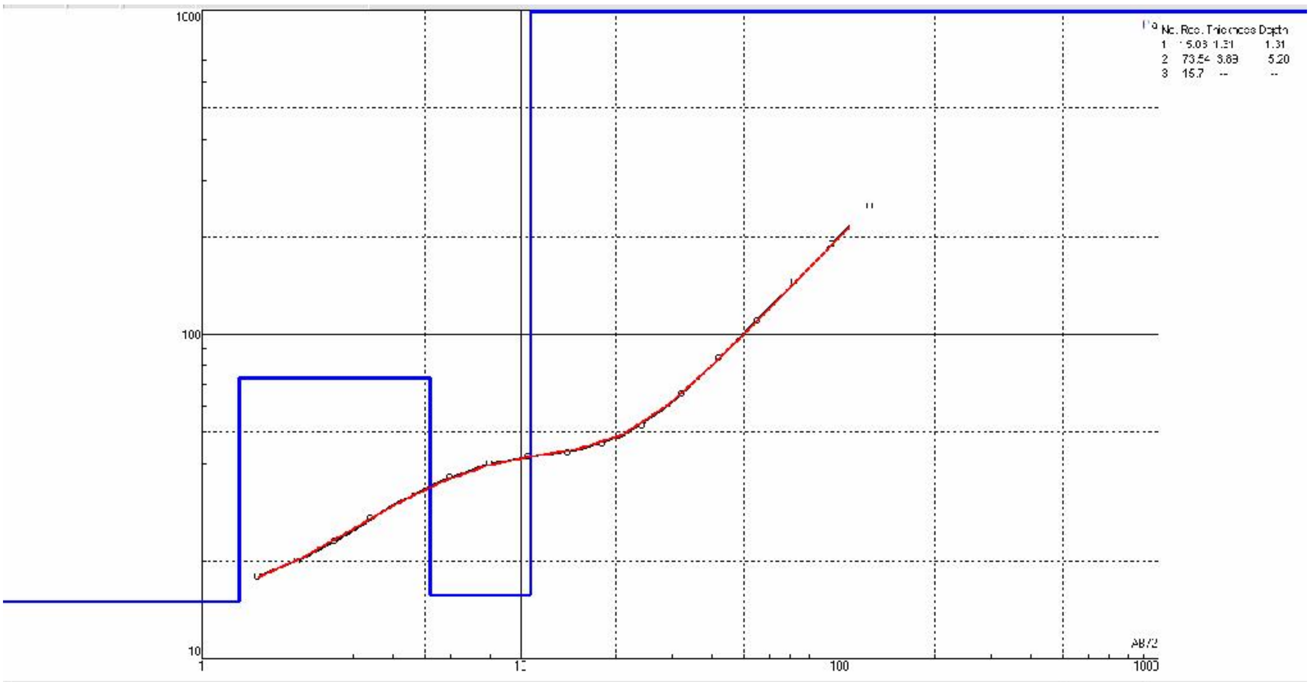

Fig.3.0. A three layers computer interpreted curve from the field data

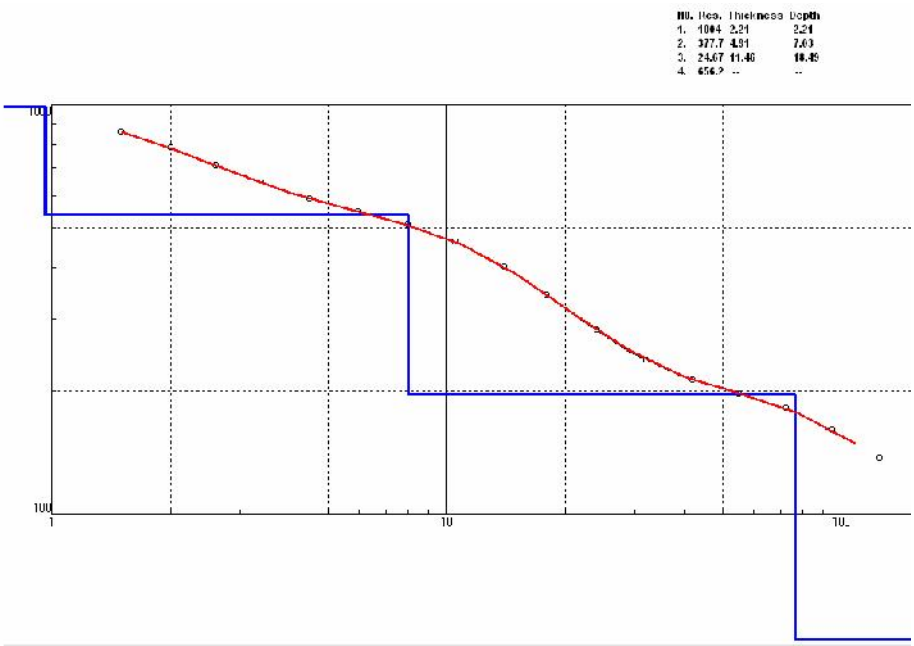

Fig. 3.1 A four layer computer interpreted curve from the field data.

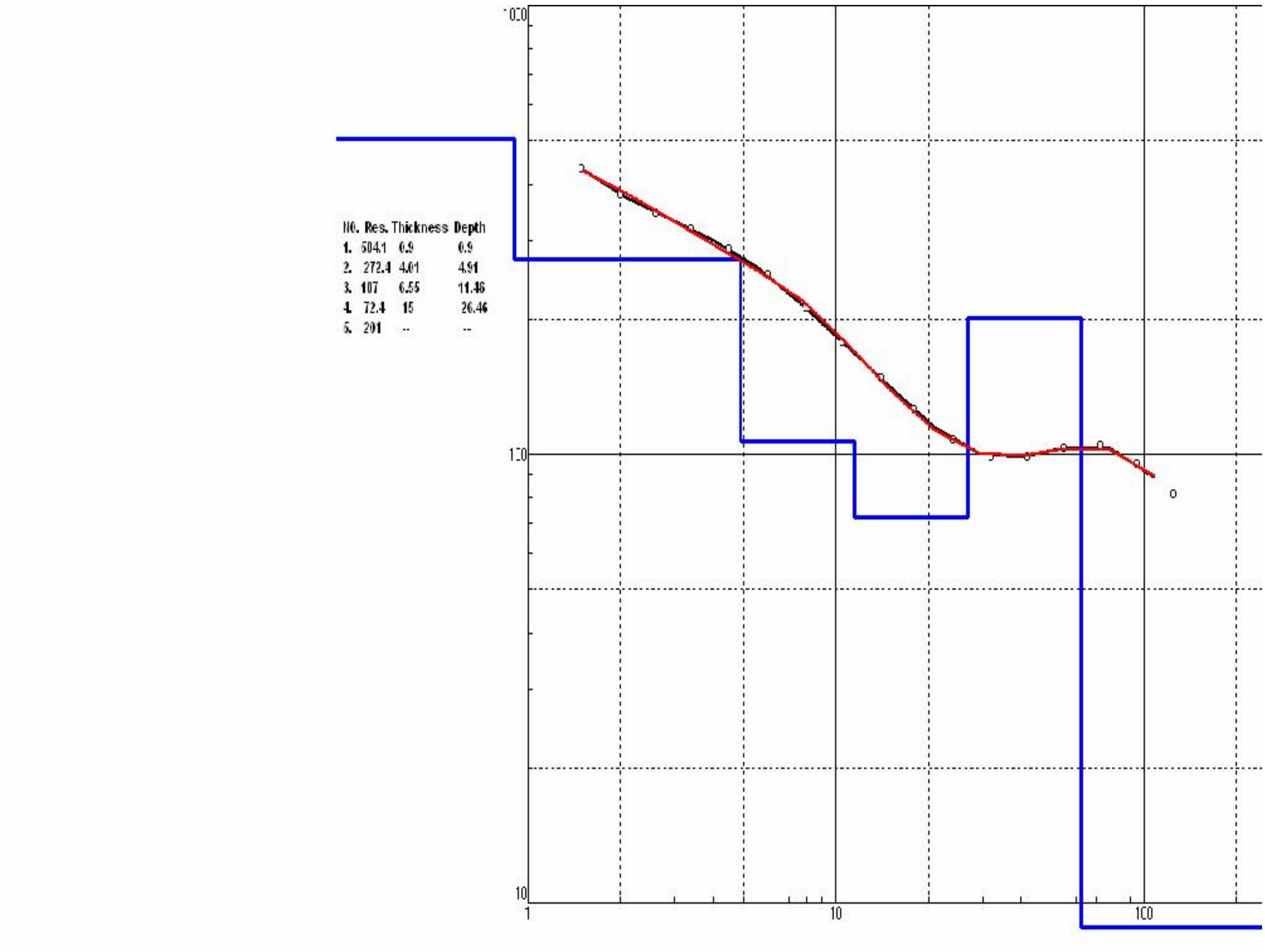

Fig.3.2: A five layer computer interpreted curve from the field data.

Qualitative Analysis

The area constitutes a non uniform distribution of subsurface lithology in various locations, which is due to discontinuous weathering which is a common characteristic of crystalline rock typical of H-type curve (Offodile, 2002).

Seven different curve types were obtained, these include: H, Q, A, HA, QH, KA and QK. Eight of the curves are Q-type with resistivity characteristic p1>p2>p3 at VES1, VES 6, VES12, VES13, VES19, VES22, VES24 and VES25.this constitutes about 32% of the total curves. The H-type curve has resistivity p1>p2<p3, it constitutes also 32% of the total curves and were obtained at VES4, VES5, VES7, VES8, VES10, VES18, VES20 and VES23.The QH-type curve with resistivity p1>p2>p3<p4, constitutes about 12% of the total curve and were obtained at VES9, VES15, and VES17. The KA-type curve has a resistivity of p1<p2>p3<p4, constitutes 8% of the total curve and was obtained at VES11 and VES 21.

The HA-type curve, with resistivity p1>p2p<3<p4, constitutes 4% of the total curves and was obtained at VES3.The A-type curve with resistivity p1<p2<p3 and constitutes also 4% 0f the total curves and was obtained at VES2.

DISCUSSION

The study area is characterized by three –five layers geoelectric sections. The layers have been identified to portray different resistivities resulting from the variations in the lithologic units. The first layer is the top soil with resistivity and thickness range between 90-668Ωm and 0.9-2.35, the layer is zone of aeration, thus serve as medium for recharge.

The second layer is laterite**,** with a resistivity and thickness range between 668-2198Ωm and 0.58-9m.this is also part of the zone of aeration, but serves as shallow aquifers for hand dug wells.

The third and fourth layers are weathered/fractured Basement with a resistivity and thickness range of 18.1-107Ωm and 10-35m, these are the expected aquiferous zones.

The fifth layer is slightly weathered-fresh unit, with a resistivity and thickness range from 139-745Ωmer and 4.08-100m, it is impervious, if fractured and well connected can serve as aquifer.

These results agree with geophysical investigation reports by Logpigrand Geotechnics, three functional boreholes were drilled in 2008 by Fatigen Drillers, with mean yield of 2L/sec (Fatigen, 2009) and aquiferous zone corresponds to the weathered/fractured bed rock. The common drilled depth ranges from 25-35m depending on the location.

The findings from the hydro-geophysical investigation are summarized on table 2

Table 2. Summary of the result showing groundwater potentials of the area

VES NO	LOCATION	POSSIBLLY AQUIFEROUS DEPTH(M)	AQUIFER CHARACTERISTICS	EXPECTED GROUND WATER POTENTIAL	RECOMMENDED DRILLING DEPTH(M)
Ves 1	Dankurma	15-20	Fracture	Low-fair	30,or all fractures been exhausted
VES 2	Dankurma	10.79	Weathered and fractured	fair	20-25
Ves 3	Saradan	19.6	weathered	moderate	25-30
Ves 4	Gurgu	-	-	Very low	not drillable
Ves 5	Rafin Sanyi	16	weathered	moderate	20-25
Ves 6	Rafin Sanyi	15	fractured	low	20-25, or all fractures exhausted
Ves 7	Angware	10	weathered	moderate	20-28
Ves 8	Angware	15	weathered	moderate	20-25
Ves 9	Angware	15	weathered	moderate	20-23
Ves 10	Angware	15	weathered	moderate	23-25
Ves 11	Zangam	14	weathered	moderate	20-25
Ves 12	zangam	30	Fracture	low	35, hand pump is preferable
Ves 13	Zangam	10	weathered	moderate	20-25
Ves 14	Angware	17	weathered	fair-moderate	23-26
Ves 15	Shere Jankasa	11	Weathered	fair	20-25
Ves 16	Angware	13	weathered	moderate	26-28
Ves 17	Angware	18.5	weathered	Low-fair	25-30
Ves 18	Rafin Sanyi	19	weathered	Fair-moderate	25-28
Ves 19	Lenge Lenge	-	-	Very low	Hand dug well
Ves 20	Lenge Lenge	22	weathered	low	24-26; preferably hand pump
Ves 21	Lenge Lenge	28	fractured	low	30-32, preferably hand pump
Ves 22	Lenge Lenge	11	weathered	fair	20-23
Ves 23	Shere Jankasa	15	weathered	Fair-moderate	23-25
Ves 24	Shere Jankasa	12	weathered		21-23
Ves 25	Shere Jankasa	-	-	Very low	Not drillable

CONCLUSION

The results of the hydrogeophysical investigation revealed that 56% of the probe points are aquiferous. These correspond to weathered/fractured unit with thickness between 10-35m. The study area therefore is capable of producing ground water from borehole when drilled to depths of 20-45m. There is also need for proper well completion to check any likely contact of surface contamination of groundwater going by the shallow depth of its occurrence.

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