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Application of Vertical Electrical Sounding for Ground Water Development in Mubi and Environs, Adamawa State North Eastern Nigeria

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Abstract: Interpretation of resistivity data for groundwater development using Vertical Electrical Sounding (VES) in Mubi and Environs, Adamawa State, North Eastern Nigeria in order to delineate potentials of groundwater as well as to determine thickness of various resistivity layers. The interpretations of the data were carried out using IP12 WIN computer software. From the interpreted results, five (5) different resistivity layers were delineated and their mean values computed with: $\rho_1 = 16\ \Omega m$, $\rho_2 = 443\ \Omega m$, $\rho_3 = 1{,}950\ \Omega m$, $\rho_4 = 12{,}156\ \Omega m$ and $\rho_5 = 5{,}891\ \Omega m$, $h_1 = 0.88$ m, $h_2 = 0.81$ m, h_3= 2,53m, $h_4 = 0.80$ m and $h_5 = 27.89$ m respectively. The depth range for the ten VES Points was found to be 11.90-57.80 m. Five (5) out of the ten VES points from the study area, namely: Digil, Arahan Kunu, Shagari Lowcost, Mayanka and Festac- Yelawa proved have potentials for groundwater development and are recommended as possible locations for siting boreholes while the other five location were not found suitable for borehole drilliing. In view of this, Mubi town and Environs have potentials for ground water exploration despite a serious complaint from the dwellers of lacking potable drinking water.

Keywords: Vertical Electrical Sounding (VES), Groundwater, IP12 WIN Software, Resistivity, Interpretation and Geo electric Layers.

I. INTRODUCTION

Of all the resources that the earth possesses, water is the most indispensable. The largest available source of fresh water lies underground. Increase demand for water has stimulated development of underground water resources (Kasidi and Lazarus, 2017). Availability of groundwater in a basement complex area depends on the thickness of aquiferous overburden and presence of water bearing fracture (Eduvie et al., 1999). Domestic water supply in Mubi comes largely from ground water, much of this is taken from hand dug wells and boreholes (Yassah, 2018). Ground water is one of the most important natural resources and availability of it is a problem to mankind. Because of the ever-increasing population in Mubi, the requirements for water supply for various purposes have increased the demand for ground water as a supplement to supplies from surface sources and in some cases as main source of water itself. Sometimes, hand dug wells and boreholes are dug or drilled with or without previous knowledge of the subsurface information. As a result, many failed boreholes exist but research has minimized the incidence of failed boreholes thereby reducing the risk as well as the cost of drilling. The use of geo electrical resistivity method can give the approximate depth to aquifer, thereby making the cost of drilling contract known. Location of aquifers by resistivity techniques of the subsurface geologic materials is used to provide data which are interpreted in terms of aquifer depth, thickness and continuity of the aquifer.

Electrical Resistivity Method has a number of advantages over other geophysical methods as reported by previous researchers (Ezomo and Akujieze, 2011). The ability of the method to give detailed information in subsurface geology usually not obtained by other methods in prospecting for ground water was presented in Ezomo and Ifedili (2005, 2007). Surface geophysical survey as instrument in ground water exploration has the basic advantage of saving cost in borehole construction by locating aquifer before embarking upon drilling (Ezomo and Ifedili, 2008). The success of geo-electrical resistivity methods for ground water studies have been found recently to depend on the intelligent application of the methods used and good interpretation of data, which requires a careful correlation of all the geophysical data collected to known geology of the area, (Beck, 1981), Beeson and Jones (1988), Olayinka and Barker (1990), Hazel (1961), Hazel etal. (1988, 1992) ,all have demonstrated the use of electrical technique for citing bore hole and wells in crystalline basement aquifer throughout the sub Saharan Africa (Badmus etal., 2008).

The present study utilized electrical resistivity method involving Schlumberger array techniques to locate the weathered and/or fractured zones for ground water exploration. The work is aimed at carrying out electrical resistivity survey to investigate and evaluate ground water potential, in some part of Mubi, Adamawa state, with a view to delineate potential for ground water and to evaluate subsurface resistivity layers. The need to conduct a surface geophysical survey such as VES to identify the localized

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acquiferous zones before sitting boreholes is emphasized by many authors such as (Ndatuwong and Yadav 2013, Nur and Goji 2005, Olayinka and Olorufemi 1992). Electrical resistivity method has been used extensively in delineating the various subsurface lithological units and also in investigating groundwater potential zones especially in the basement complex terrain (Mbanu et al, 1991, Nur and Ayuni, 2004, Nur et al 2006).

II. LOCATION, GEOLOGY AND HYDROGEOLOGY OF THE STUDY AREA

The study area is located within Mubi area and falls within the Basement Complex of North eastern part of Nigeria between Latitudes 10°12' N and 10°21¹ N and longitudes 13°10¹ E and 13°21¹ E (Fig 1). It is about 200 km north east of Yola, and patches of fertile soils in some areas support many crops such as rice, millet, guinea corn, maize, potatoes and cowpea. The area is largely drained by River Yardzaram and its tributaries .The people of Mubi are predominantly farmers and therefore Ground water is an important source of water supply, and plays an important role in industry, agriculture and for domestic use.

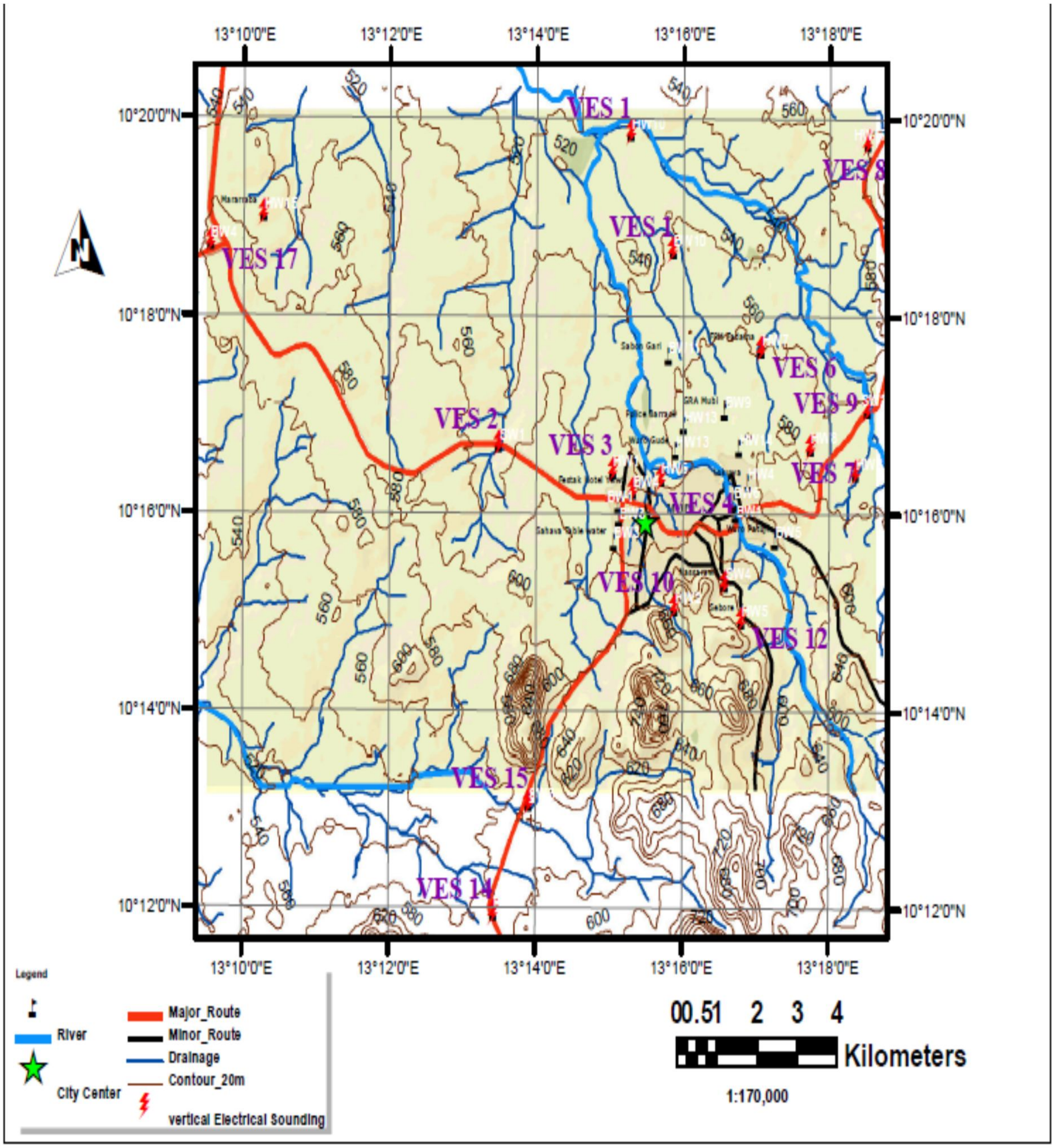

Fig. 1 Topographic Map of the Study Area showing VES points (FSN, 1970

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A. Uba -Sheet 156 Superimposed): FSN = Federal Survey, Nigeria.

The geology of the study area consist of pre-cambrian basement complex mainly migmatites and gneiss complex, older granite and volcanic rocks (Fig.2). The rocks in Mubi are of pre pan Africa orogeny (gneisses and migmatites) or older granites and occupy mainly the lowlands as small outcrops. They are banded, foliated with felsic and ferromagnesian minerals forming the light and dark bands respectively.

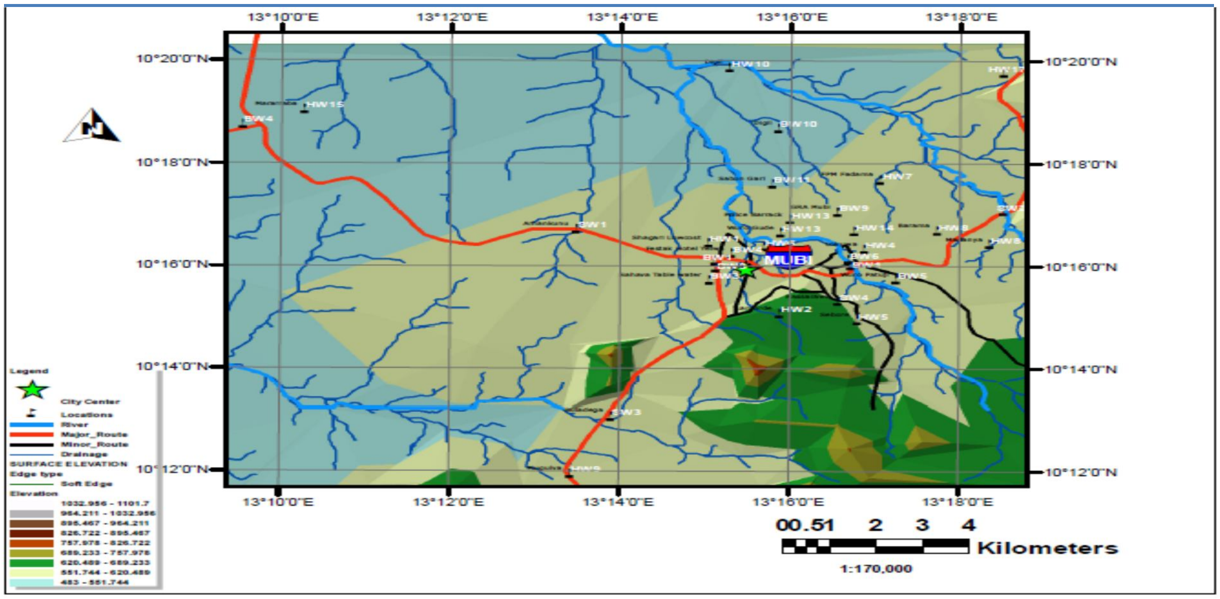

Figure 2.1 Geological Map of the Study Area (FSN, 1970 Uba Sheet 156 Map) Showing VES points superimposed.

This mineral differentiation imparts the foliation to the rocks. The older granites which are younger are intrusive to the gneissic and magmatic rocks (Adebayo, 2010). The oldest rocks of the area, the gneisses which are believed to be of birrimian age (Oyawoye, 1970) are overlain by recent alluvium resulting from the weathering and erosion of hills and decomposed rock material. They cover a large part of the crystalline basement rocks. These types of rocks usually form no good aquifers for groundwater storage.

The study area lies within the North-Easter basement complex, in this area, there are two main types of aquifer in the basement complex area. They include: The porous, broken, decomposed rocks (i.e. weathered basement or over burden) and the fractured zones of fresh rocks. The weathered basement consists of mainly of in-situ decomposed rocks. At shallow depth, the decomposed rocks are characteristically clayey, concretionary brown to reddish brown ferruginous and lateritic (Shemang and Umaru, 1994). The decomposed rocks which overlie the crystalline rocks is largely covered by thin blanket of alluvium consisting mainly of lenses of silts, clays, sands, gravel and local intermixes of these materials and boulders. These materials were derived mainly from weathering of adjacent hills and reworked alluvium (Umaru and Schoeneick 1992). Most of the fractured zones are buried beneath the overburden materials through which it received its own recharge and it requires more details methods of geological investigation to delineate them. Fracture in basement terrain tend to store and transmit water fairly well near the surface but become tighter with depth below 100m even though there is effectively no storage due to crystalline rocks. The greater the total thickness of the weathered and fractured layers forming the aquifer the greater its water bearing capacity (Kasidi and Lazarus, 2017).

III. MATERIALS AND METHOD

In this research work, the method employed for the study is electrical resistivity survey involving vertical electrical soundings (VES). This method is a geophysical exploration method for investigating groundwater, the subsurface distribution of electrical resistivity by introducing low frequency or direct electrical current into the ground via spike electrodes and measuring the resulting voltage difference with a second electrode pair. The two principal techniques are the constant separation traversing and vertical electrical sounding. Vertical electrical sounding (VES) is a resistivity method in which the current electrodes are expanded symmetrically so that the current penetrates progressively deeper into the subsurface. By performing a vertical electrical sounding (VES), linear electrodes array is laid out in the field injecting a direct current into the ground, while at the center the voltage response is measured simultaneously between two electrodes (Fig. 3).

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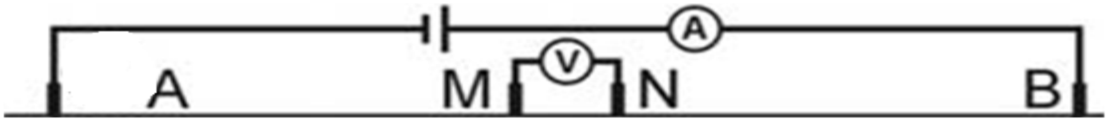

Fig.3: Schlumberger array configuration

Increasing depths are realized by enlargement of the current electrodes from very small distance at the beginning to longer distances at the end of the array. Resistivity prospecting method is one of the electrical methods, well developed and versatile in its application for groundwater investigation. The method utilizes electrical properties of rocks. In most rocks, their electrical properties in the upper part of the earth crust are dependent primarily upon the amount of water in the rocks, the salinity of the water and its distribution in the rocks. This means that saturated rocks have lower resistivity than the unsaturated and dry rocks (Kasidi and Lazarus, 2017). Ten Vertical Electrical Soundings (VES) using the Schulumberger array were carried out to obtain data by a terrameter SAS 300B in order to determine resistivity of different layers in the study area. This is due to its numerous applications in geology, hydrogeology and related engineering problems. As AB gets larger, the potential set up between the electrodes exceeds the measuring capacities of the instrument; this is due to the fact that the field at the Centre of the configuration varies inversely as the square of the length of the configuration AB. When this situation occurs, a new value typically about three times larger than the preceding value is established for MN.

Duplicating the last two values with new MN value then continued the procedure for measurement of the potential difference. The fact that the potential electrodes in the Schlumberger arrangement remain fixed during a large number of successive measurement makes it sensitive to unknown lateral in homogeneities which when they exist affect the field curves obtained and interpretation adversely. In this way, it has a greater advantage over other configurations.

The data obtained by this method were used for the interpretation of results.

Interpretation of the VES data was done using log-log graph sheet for smoothening and computer software IP12 WIN was used for the quantitative interpretation.

It is designed for the interpretation of vertical electrical soundings and induced polarization, data collected geophysically are treated as a unity presenting the geophysical structure of the survey area as a whole, rather than a set of independent objects, the program has the ability to interpret resistivity data under two modes, interactive semi-automated mode and automated interactive mode. Schlumberger array configuration with a maximum electrode spacing of AB = 320m (AB/2 =160m) was used for the research work and the result of the ten VES points from the study area were computed and then interpreted accordingly.

IV. RESULTS

The results obtained for the Vertical Electrical Soundings (VES) using IP12 WIN computer software from the study area are presented in tables and graphs as follows;

Table 1: Results from Computed Output of Ten (10) VES Points in the Study Area

VES NO	Thickness of Layers(m)					Depth d(m)	Resistivity of Layers (Ωm)				
	h_1	h_2	h_3	h_4	h_5		ρ_1	ρ_2	ρ_3	ρ_4	ρ_5
1	1.48	1.25	0.04	3.04	6.58	12.60	245.00	962.00	2.87	93.20	10602.00
2	0.50	0.70	2.48	12.70	71.50	16.40	99.40	734.00	10.00	1066.00	234.00
3	0.50	1.05	0.05	9.36	22.10	35.50	2.17	205.00	16.40	3.27	75.40
4	1.77	0.90	8.18	32,20	14.70	57.80	31.30	4.45	109.00	20.30	2.99
5	0.50	0.17	3.00	3.09	39.60	46.40	217.00	8.33	479.00	11.70	44.40
6	0.51	0.27	1.03	3.92	10.10	15.80	370.00	73.00`	1218.00	123.00	9214.00
7	0.50	0.60	0.06	1O.80	59.90	11.90	88.40	21.20	4032.00	182.00	4473.00
8	0.50	0.10	4.06	2.42	23.70	31.60	410.00	2354.00	2354.00	16387.00	33081.00
9	1.34	2.60	5.58			9.52	31.40	31.40	20148.00		
10	1.19	1.45	0.79	2.91`	30.70	37.10	91.70	38.50	1130.00	104673.00	982.00
MEAN	0.88	0.81	2.53	0.80	27.89	26.46	15.76	442.99	1949.89	12155.93	5890.88

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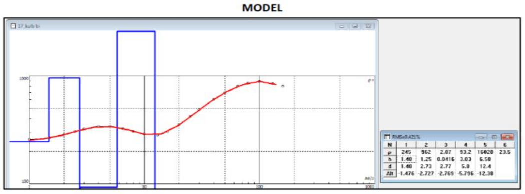
Header Information		
GPS Location	**Project Name:** MSc. Project	**Date:15/07/13**
X:308900.729	**Elevation:** 522.833m	Data Point : VES 1
Y: 1142546.437	Data Name: Digil	Array Type: Schlumberger

FIELD DATA

AB/2	MN	SP	V	I	K	Ro_a
1	0.4	0	33.65	1	7.5398	253.72
1.5	0.4	0	15.5	1	17.357	269.04
2	0.4	0	9.4	1	31.102	292.36
2.5	0.4	0	5.9	1	48.773	287.76
3	0.4	0	4.1	1	70.372	288.52
4	0.4	0	2.5	1	125.35	313.37
5	0.4	0	1.8	1	196.04	352.86
6.5	0.4	0	1.2	1	331.52	397.82
8	0.4	0	0.979	1	502.34	491.79
10	0.4	0	0.89	1	785.08	698.72
8	3	0	3	1	64.664	193.99
10	3	0	1.8	1	102.36	184.25
13	3	0	1.1	1	174.62	192.08
16	3	0	0.816	1	265.73	216.83
20	3	0	0.656	1	416.52	273.24
25	3	0	0.469	1	652.14	305.85
30	3	0	0.406	1	940.12	381.69
40	3	0	0.406	1	1673	679.3
50	3	0	0.556	1	2616	1454
65	3	0	0.566	1	4422	2503
80	3	0	0.147	1	6700	984.86
100	3	0	0.4	1	10470	4188
80	32	0	0.145	1	603.19	87.462
100	32	0	0.386	1	956.61	369.25
130	32	0	0.357	1	1634	583.35
160	32	0	0.336	1	2488	836.02

MODEL

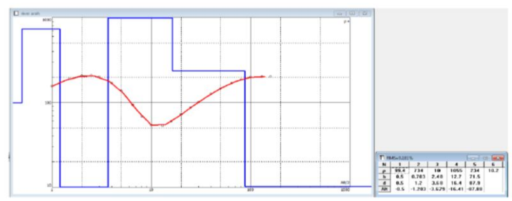


Header Information		
GPS Location	**Project Name:** MSc. Project	**Date:15/7/13**
X:305597	**Elevation:** 549.094m	Data Point : VES 2
Y:1136741	Data Name: Arhankunu	Array Type: Schlumberger

FIELD DATA

AB/2	MN	SP	V	I	K	Ro_a
1	0.4	0	23.39	1	7.5398	176.36
1.5	0.4	0	4	1	17.357	69.429
2	0.4	0	4.8	1	31.102	149.29
2.5	0.4	0	2.3	1	48.773	112.18
3	0.4	0	140	1	70.372	9852
4	0.4	0	0.681	1	125.35	85.363
5	0.4	0	0.379	1	196.04	74.297
6.5	0.4	0	0.203	1	331.52	67.298
8	0.4	0	0.16	1	502.34	80.375
10	0.4	0	0.059	1	785.08	46.32
8	3	0	0.758	1	64.664	49.016
10	3	0	0.561	1	102.36	57.426
13	3	0	0.284	1	174.62	49.592
16	3	0	0.2	1	265.73	53.145
20	3	0	0.25	1	416.52	104.13
25	3	0	0.209	1	652.14	136.3
30	3	0	0.085	1	940.12	79.91
40	3	0	0.062	1	1673	103.74
50	3	0	0.048	1	2616	125.55
65	3	0	0.045	1	4422	198.99
80	3	0	0.032	1	6700	214.39
100	3	0	0.031	1	10470	324.56
80	32	0	0.234	1	603.19	141.15
100	32	0	0.159	1	956.61	152.1
130	32	0	0.115	1	1634	187.91
160	32	0	0.089	1	2488	221.44

MODEL

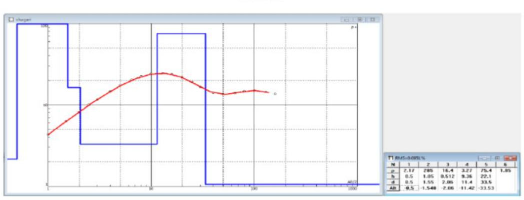


Header Information		
GPS Location	**Project Name:** MSc. Project	**Date:**
X:308446	**Elevation:** 569.671m	Data Point : VES 3
Y:1136237	Data Name: Shagari Lowcost	Array Type: Schlumberger

FIELD DATA

AB/2	MN	SP	V	I	K	Ro_a
1	0.4	0	2.89	89	7.5398	0.24483
1.5	0.4	0	0.898	1	17.357	15.587
2	0.4	0	0.517	1	31.102	16.08
2.5	0.4	0	0.357	1	48.773	17.412
3	0.4	0	0.261	1	70.372	18.367
4	0.4	0	0.165	1	125.35	20.683
5	0.4	0	0.117	1	196.04	22.936
6.5	0.4	0	0.075	1	331.52	24.864
8	0.4	0	0.052	1	502.34	26.122
10	0.4	0	0.362	1	785.08	284.2
8	3	0	0.296	1	64.664	19.141
10	3	0	0.2	1	102.36	20.473
13	3	0	0.116	1	174.62	20.256
16	3	0	0.072	1	265.73	19.132
20	3	0	0.044	1	416.52	18.327
25	3	0	0.013	1	652.14	8.4778
30	3	0	0.019	1	940.12	17.862
40	3	0	0.011	1	1673	18.405
50	3	0	0.003	1	2616	7.8469
65	3	0	0.005	1	4422	22.11
80	3	0	0.007	1	6700	46.898
100	3	0	0.009	1	10470	94.227
80	32	0	0.004	1	603.19	2.4127
100	32	0	0.0085	1	956.61	8.1312
130	32	0	0.0065	1	1634	10.621
160	32	0	0.0055	1	2488	13.685

MODEL



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X:309643.954	**Elevation:** 556.1m	Data Point : VES 4
Y:1136087.767	Data Name: Ernest's R. Mayanka	Array Type: Schlumberger

FIELD DATA

AB/2	MN	SP	V	I	K	Ro_a
1	0.4	0	3.9	1	7.5398	29.405
1.5	0.4	0	1.65	1	17.357	28.64
2	0.4	0	0.808	1	31.102	25.13
2.5	0.4	0	0.46	1	48.773	22.436
3	0.4	0	0.291	1	70.372	20.478
4	0.4	0	0.135	1	125.35	16.922
5	0.4	0	0.076	1	196.04	14.899
6.5	0.4	0	0.046	1	331.52	15.25
8	0.4	0	0.031	1	502.34	15.573
10	0.4	0	0.022	1	785.08	17.272
8	3	0	0.251	1	64.664	16.231
10	3	0	0.207	1	102.36	21.189
13	3	0	0.121	1	174.62	21.129
16	3	0	0.097	1	265.73	25.775
20	3	0	0.091	1	416.52	37.904
25	3	0	0.069	1	652.14	44.998
30	3	0	0.06	1	940.12	56.407
40	3	0	0.084	1	1673	140.55
50	3	0	0.069	1	2616	180.48
65	3	0	0.046	1	4422	203.41
80	3	0	0.045	1	6700	301.49
100	3	0	0.04	1	10470	418.78
80	32	0	0.043	1	603.19	25.937
100	32	0	0.039	1	956.61	37.308
130	32	0	0.035	1	1634	57.191
160	32	0	0.032	1	2488	79.621

MODEL

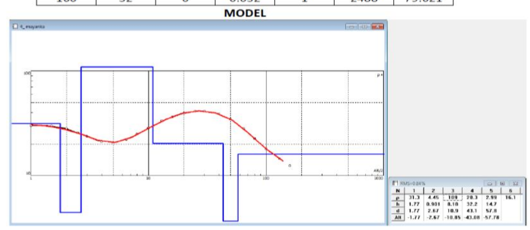

Fig3 Showing results and curves of VES 1-4 from the Study area.

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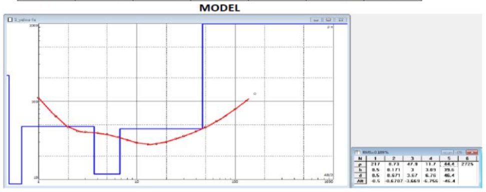
Header Information		
GPS Location	**Project Name:** MSc. Project	**Date:15/7/13**
308941.104	**Elevation:** 563.676m	Data Point : VES 5
1135857.042	Data Name: Festak Hotel Yelwa	Array Type: Schlumberger

FIELD DATA

AB/2	MN	SP	V	I	K	Ro_a
1	0.4	0	15.28	1	7.5398	115.21
1.5	0.4	0	3.5	1	17.357	60.751
2	0.4	0	1.54	1	31.102	47.897
2.5	0.4	0	0.934	1	48.773	45.554
3	0.4	0	0.555	1	70.372	39.056
4	0.4	0	0.298	1	125.35	37.354
5	0.4	0	0.184	1	196.04	36.071
6.5	0.4	0	0.119	1	331.52	39.45
8	0.4	0	0.071	1	502.34	35.666
10	0.4	0	0.04	1	785.08	31.403
8	3	0	0.446	1	64.664	28.84
10	3	0	0.241	1	102.36	24.67
13	3	0	0.162	1	174.62	28.288
16	3	0	0.107	1	265.73	28.433
20	3	0	0.069	1	416.52	28.74
25	3	0	0.05	1	652.14	32.607
30	3	0	0.038	1	940.12	35.725
40	3	0	0.028	1	1673	46.848
50	3	0	0.02	1	2616	52.313
65	3	0	0.015	1	4422	66.331
80	3	0	0.012	1	6700	80.396
100	3	0	0.01	1	10470	104.7
80	32	0	0.011	1	603.19	6.635
100	32	0	0.089	1	956.61	85.139
130	32	0	0.075	1	1634	122.55
160	32	0	0.058	1	2488	144.31

MODEL



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X:311229	**Elevation:** 571.579m	Data Point : VES 6
Y:1137335	Data Name: Fed Poly Mubi	Array Type: Schlumberger

FIELD DATA

AB/2	MN	SP	V	I	K	Ro_a
1	0.4	0	37.8	1	7.5398	285.01
1.5	0.4	0	16.05	1	17.357	278.58
2	0.4	0	7.7	1	31.102	239.48
2.5	0.4	0	4.29	1	48.773	209.24
3	0.4	0	4.01	1	70.372	282.19
4	0.4	0	5.69	1	125.35	713.24
5	0.4	0	1.6	1	196.04	313.66
6.5	0.4	0	1.68	1	331.52	556.95
8	0.4	0	2.47	1	502.34	1241
10	0.4	0	2.47	1	785.08	1939
8	3	0	1.28	1	64.664	82.77
10	3	0	1	1	102.36	102.36
13	3	0	0.84	1	174.62	146.68
16	3	0	0.995	1	265.73	264.4
20	3	0	1.34	1	416.52	558.14
25	3	0	0.467	1	652.14	304.55
30	3	0	1.65	1	940.12	1551
40	3	0	0.456	1	1673	762.96
50	3	0	0.282	1	2616	737.61
65	3	0	0.949	1	4422	4197
80	3	0	1.25	1	6700	8375
100	3	0	1.72	1	10470	18008
80	32	0	1.22	1	603.19	735.89
100	32	0	0.98	1	956.61	937.48
130	32	0	0.65	1	1634	1062
160	32	0	0.36	1	2488	895.73

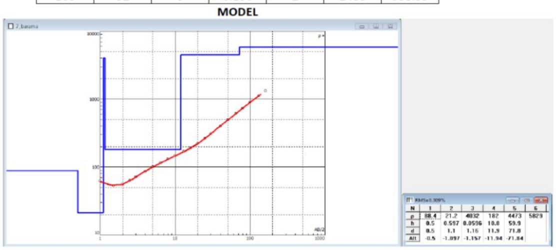
MODEL

Header Information		
GPS Location	**Project Name:** MSc. Project	**Date: 15/7/13**
X:313365	**Elevation:** 574.496m	Data Point : VES 7
Y:1136656	Data Name: Barama	Array Type: Schlumberger

FIELD DATA

AB/2	MN	SP	V	I	K	Ro_a
1	0.4	0	28.52	1	7.5398	215.04
1.5	0.4	0	0.277	1	17.357	4.808
2	0.4	0	2.82	1	31.102	87.707
2.5	0.4	0	3.3	1	48.773	160.95
3	0.4	0	1.78	1	70.372	125.26
4	0.4	0	0.995	1	125.35	124.72
5	0.4	0	0.598	1	196.04	117.23
6.5	0.4	0	0.494	1	331.52	163.77
8	0.4	0	0.201	1	502.34	100.97
10	0.4	0	0.107	1	785.08	84.004
8	3	0	2.77	1	64.664	179.12
10	3	0	2.46	1	102.36	251.81
13	3	0	0.608	1	174.62	106.17
16	3	0	0.415	1	265.73	110.28
20	3	0	0.357	1	416.52	148.7
25	3	0	0.4	1	652.14	260.86
30	3	0	0.316	1	940.12	297.08
40	3	0	0.219	1	1673	366.42
50	3	0	0.102	1	2616	266.8
65	3	0	1.37	1	4422	6058
80	3	0	0.213	1	6700	1427
100	3	0	0.118	1	10470	1235
80	32	0	0.333	1	603.19	200.86
100	32	0	0.417	1	956.61	398.91
130	32	0	0.69	1	1634	1127
160	32	0	0.136	1	2488	338.39

MODEL



Header Information		
GPS Location	**Project Name:** MSc. Project	**Date:15/7/13**
X:314805.445	**Elevation:** 578.191m	Data Point : VES 8
Y:1142338.035	Data Name: Vimtim	Array Type: Schlumberger

FIELD DATA

AB/2	MN	SP	V	I	K	Ro_a
1	0.4	0	79.9	1	7.5398	602.43
1.5	0.4	0	61.6	1	17.357	1069
2	0.4	0	43	1	31.102	1337
2.5	0.4	0	47	1	48.773	2292
3	0.4	0	35	1	70.372	2463
4	0.4	0	42	1	125.35	5265
5	0.4	0	39	1	196.04	7645
6.5	0.4	0	27	1	331.52	8951
8	0.4	0	47	1	502.34	23610
10	0.4	0	20	1	785.08	15702
8	3	0	12	1	64.664	775.97
10	3	0	7	1	102.36	716.54
13	3	0	6	1	174.62	1048
16	3	0	9	1	265.73	2392
20	3	0	14	1	416.52	5831
25	3	0	12	1	652.14	7826
30	3	0	11	1	940.12	10341
40	3	0	5	1	1673	8366
50	3	0	7	1	2616	18309
65	3	0	8	1	4422	35376
80	3	0	4	1	6700	26799
100	3	0	7	1	10470	73287
80	32	0	0.442	1	603.19	266.61
100	32	0	1.7	1	956.61	1626
130	32	0	3.6622	1	1634	5984
160	32	0	3.23	1	2488	8037

MODEL

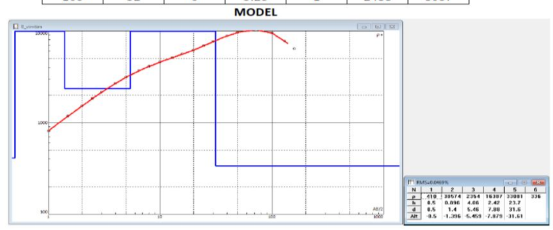


Fig4 Showing results and curves of VES 5-8 from the study area.

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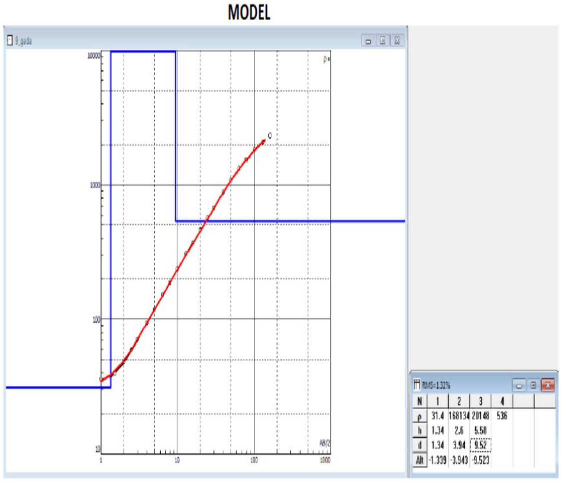
Header Information

GPS Location	Project Name: MSc. Project	Date:
X:314799	Elevation: 564.323m	Data Point : VES 9
Y:1137357	Data Name: Kogin Gada	Array Type: Schlumberger

FIELD DATA

AB/2	MN	SP	V	I	K	Ro_a
1	0.4	0	5	1	7.5398	37.699
1.5	0.4	0	2	1	17.357	34.715
2	0.4	0	1.6	1	31.102	49.763
2.5	0.4	0	1.2	1	48.773	58.528
3	0.4	0	0.867	1	70.372	61.012
4	0.4	0	0.603	1	125.35	75.586
5	0.4	0	0.581	1	196.04	113.9
6.5	0.4	0	0.663	1	331.52	219.8
8	0.4	0	0.548	1	502.34	275.28
10	0.4	0	0.385	1	785.08	302.26
8	3	0	1.7	1	64.664	109.93
10	3	0	1.63	1	102.36	166.85
13	3	0	1.3	1	174.62	227.01
16	3	0	1.2	1	265.73	318.87
20	3	0	0.935	1	416.52	389.45
25	3	0	0.892	1	652.14	581.71
30	3	0	0.765	1	940.12	719.19
40	3	0	0.496	1	1673	829.89
50	3	0	0.918	1	2616	2401
65	3	0	0.274	1	4422	1212
80	3	0	0.402	1	6700	2693
100	3	0	1.5	1	10470	15704
80	32	0	1.26	1	603.19	760.01
100	32	0	0.841	1	956.61	804.51
130	32	0	0.841	1	1634	1374
160	32	0	0.626	1	2488	1558

MODEL



Header Information

GPS Location	Project Name: MSc. Project	Date:15/7/13
X:309979	Elevation: 611.15m	Data Point : VES 10
Y:1133675	Data Name: Lamurde	Array Type: Schlumberger

FIELD DATA

AB/2 (m)	MN/2 (m)	SP	R(Ohm)	I	K	ρa
1	0.4	0	10.3	1	7.54	77.66
1.5	0.4	0	5.5	1	17.4	95.7
2	0.4	0	2.8	1	31	86.8
2.5	0.4	0	1.6	1	49	78.4
3	0.4	0	1	1	70	70
4	0.4	0	0.708	1	125	88.5
5	0.4	0	0.417	1	196	80.75
6.5	0.4	0	0.273	1	332	90.64
8	0.4	0	0.151	1	502	75.8
10	0.4	0	0.167	1	785	131.1
8	3	0	0.708	1	65	46.02
10	3	0	0.43	1	102	43.86
13	3	0	0.833	1	175	145.78
16	3	0	0.834	1	266	221.84
20	3	0	1.71	1	417	504.57
25	3	0	0.804	1	652	524.21
30	3	0	1.09	1	940	1024.6
40	3	0	0.996	1	1673	1668.3
50	3	0	0.73	1	2616	1909.68
65	3	0	0.504	1	4422	2228.69
80	3	0	0.517	1	6700	3463.9
100	3	0	0.598	1	10470	6261.06
80	32	0	0.5512	1	605	331.82
100	32	0	0.582	1	957	556.97
130	32	0	0.486	1	1634	794.12
160	32	0	0.454	1	2488	1129.55

MODEL

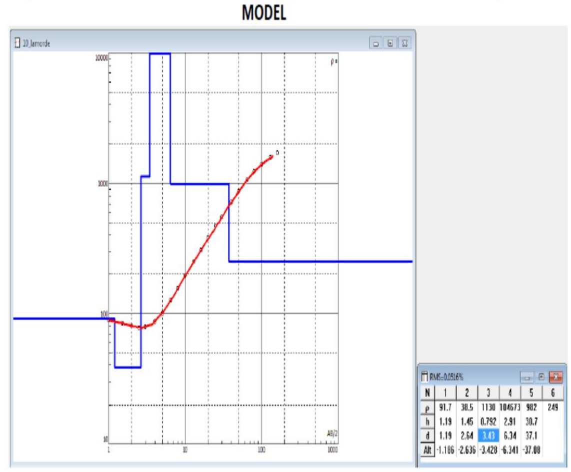


Fig5 Showing results and curves of VES 8-9 from the Study area.

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Table 2: Summary of Curve types and Groundwater potentials in the Study Area

VES NO	CURVE TYPE	POTENTIALS FOR GOUNDWATER
1	AKH	YES
2	KHA	YES
3	AKQ	YES
4	HAK	YES
5	QQH	YES
6	HAA	NO
7	HAA	NO
8	AAK	N0
9	A	NO
10	HAA	NO

V DISCUSSION

Computed results of the 10 VES field measurements are presented in table 1 The values of spacing all the 10 VES points were plotted on x-axis (abscissa) while the apparent resistivities (ρ_a) were plotted on the Y-axis (0rdinate of a log-log graph sheet. The curves were smoothening, the numbers of layers were determined and quantitatively interpreted using a computer software program IP12WIN 2003 MODEL. These are shown in the figures 3, 4 and 5 above,

The result in table 1 showed that the study area has a minimum of three layers (VES9) and maximum of five layers (all the remaining VES points obtained in the study area).

The average value of each thickness and resistivity of each layer is calculated and the values are given as follows: h_1 = 0.88 m, h_2 = 0.81 m, h_3 =2.53 m, h_4 = 0.80 m and h_5 =27.89 m. The average resistivity values of the layers are ρ_1 =16 Ωm, ρ_2 =443 Ωm, ρ_3 = 1, 950 Ωm, ρ_4 = 12,156 Ωm, and ρ_5 = 5, 891 Ωm respectively.

The quantitative interpretation of the vertical electrical sounding has helped in delineating the aquiferous zones and thicknesses of the rock layers in Mubi and its environs. The VES interpreted results are summarized in table 1 and 2. From the analysis of interpreted results obtained from the study area (Mubi and its environs), four distinct layers may be recognized as follows: the first layer is the surface unit made up of a mixture of top soil sand, clay and alluvium materials with mean thickness o.88 m and an average resistivity value of 16 Ωm. The second layer is interpreted as a mixture gravels and wet sand with a mean thickness of 0.81 m and an average resistivity value of 443 Ωm.

The third layer which is interpreted to be a layer of weathered/fractured basement (consisting of migmatite-gness) has an average resistivity value of 1,950 Ωm with a mean thickness of 27.50 m. The fourth layer is interpreted as a layer of fresh bedrock and it is found to be present and continuous down the subsurface in the study area. The interpreted results showed that this layer has a mean thickness of 27.89 m and with an average resistivity value of 12,155 Ωm. The depth range from the study area is found to be between 11.90- 57.80 m. The above results agreed with data of existing boreholes in the study area which suggested that the depth of water bearing zone in the study area range from12m to 60m.

Table 2 showed results of curve types and groundwater potentials. Five (5) out of the ten VES points from the study area, namely: Digil, Arahan Kunu, Shagari Lowcost, Mayanka and Festac- Yelawa have potentials for groundwater development.

VI. CONCLUSION

This research was carried out based on the application of vertical electrical sounding principles of resistivity survey which is the method of geophysical exploration that probes subsurface rocks using their geo-electric properties. Ten(10) VES points were sounded and interpreted using 1P12 WIN Computer software. The interpreted result revealed a minimum of three and a maximum of five geo-electric layers. The first layer is the surface unit made up of a mixture of top soil sand, clay and alluvium materials. The second layer is interpreted as a mixture gravels and wet sand. The third layer is interpreted to be a layer of weathered/fractured basement (consisting of migmatite-gness) and the fourth layer is interpreted as a layer of fresh bedrock and it is found to be present and continuous down the subsurface in the study area. In this research work, five (5) out of ten (10)VES points investigated, proved to have potentials for ground water while the other five locations do not have.

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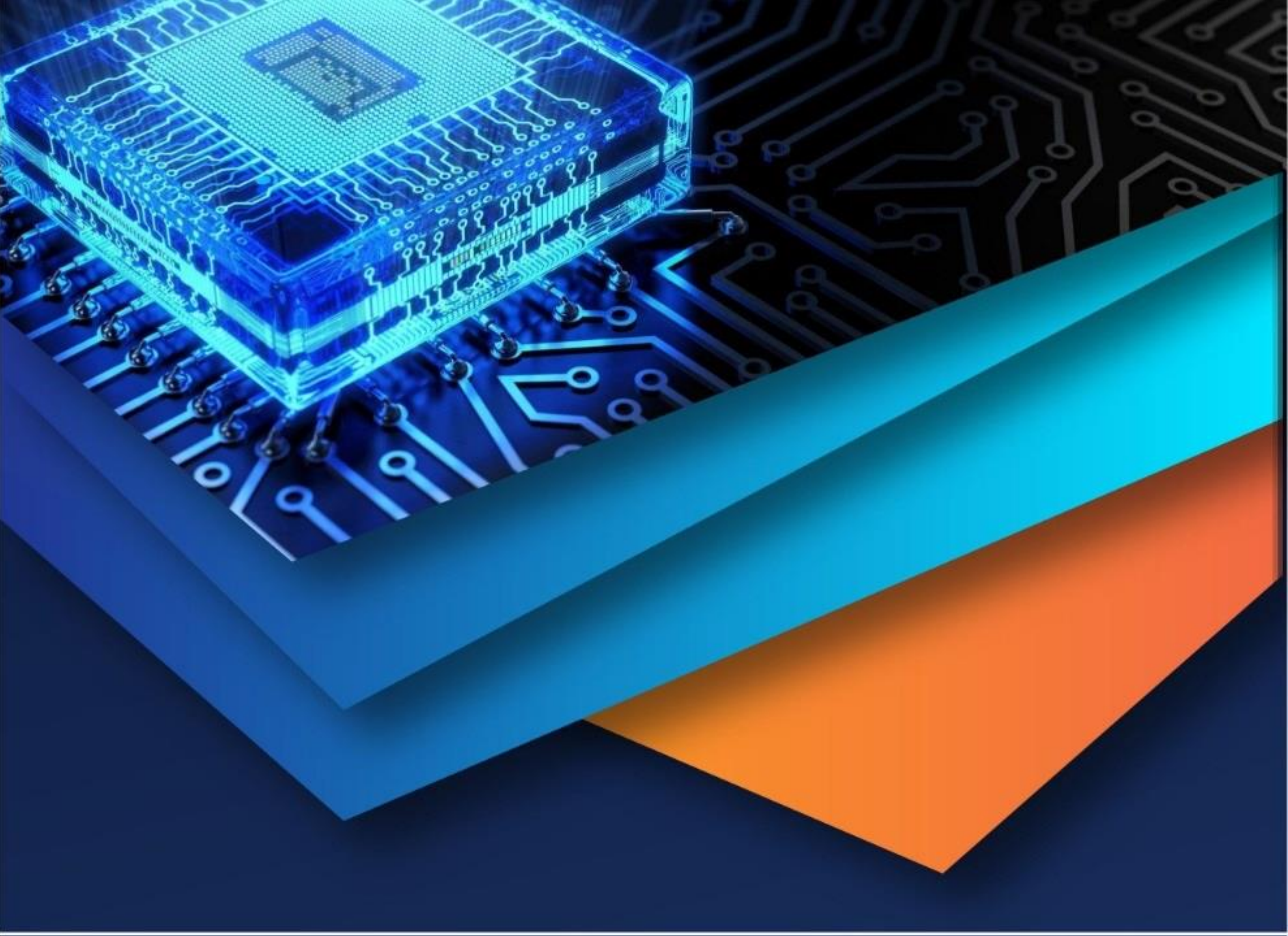

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