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Groundwater Exploration Using Vertical Electrical Sounding (Ves) Method In Musawa And Environs Of Katsina State, Nigeria.

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Abstract: *Groundwater exploration using vertical Electrical Sounding (VES) methodwhich is the aim of this investigation was carried out in Musawa and Environs of Katsina State, North-western Nigeria, in order to study the aquifer characteristic with a view of determining the depth and thickness of sediments layers, and recommend suitable depth with groundwater potentials and abundance. Ten VES points were conducted in musawa and the Schlumberger electrodes configuration was used for the field data acquisition. The field data obtained was analyzed using IP2WIN computer software which gives an automatic interpretation of the apparent resistivity. Interpretation of VES stations data results reviled the subsurface geologic sequence (litho-logic layers) and the expected layers of aquifer. The maximum depth of study range is between 60m to 90m and the depth of water table is prospected between 55m and 60m.Ten (VES) points were subjected to the geophysical method of investigation for this research, out of which 7 VES points have shown groundwater potentials which includes VES 1,3,4,5,6,8,9 at the depth of 55-60m while VES 2, 7 and 10 have shown inadequate groundwater potentials.*

Keywords: *Groundwater, Resistivity, IP2WIN, Lithology,and Basement*

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I. Introduction

Water is one of the world's most important resources on earth, which is very essential to both plants and animals for survival. Water is very important for maintenance of life, health and social stability, and it occurs both on the surface and subsurface of the earth. Subsurface water is referred to as groundwater, while the surface water includes; lakes, rivers, and ocean etc. Despite the abundance of water on earth surface, the search for groundwater becomes necessary and continues. The availability of quality water resources has always been the primary concern of governments and societies in basement complex areas, even in areas of more abundant rainfall, the problem of obtaining adequate supply of quality water is generally becoming more acute due to ever increasing population and industrialization. As a result of these, surface water cannot be dependable throughout the year, hence, the need to look for other alternatives to supplement surface water (Alisiobi and Ako, 2012). Several methods employed in groundwater exploration include electrical resistivity, gravity, seismic, magnetic, remote sensing, electromagnetic, among others, out Vertical Electrical Sounding (VES) technique provide information on the vertical variation in the resistivity of the ground with depth . A lot of geophysical investigations have been carried out in different parts of the world for groundwater investigation. Among the various geophysical methods of groundwater investigation, the electrical resistivity method has the widest adoption in groundwater exploration in basement complex rock (Ariyo, 2007 and Olorunfemi, 1999). This is due to the fact that the field operation is easy, the equipment is portable, less filled pressure is required, it has greater depth of penetration and it is accessible to method communication systems (i.e. computer). This is the method employed in the study area Musawa. Oloruniwo and Olorunfemi (1987) used the electrical resistivity method for groundwater investigation in parts of the Basement terrain in Southwest Nigeria and concluded that the weathered layer and the fractured Basement constitute the aquifer zones. Sadeeq and Salahudeen (2016a; b) conducted a geophysical investigation for groundwater prospecting using SAS 300 geophysical survey instrument and dedicated geophysical software for data processing.They concluded that this method and procedure yielded acceptable results.

II. Location And Accessibility

Musawa is a local Government area inKatsina state, its headquarter is in the town of Musawa with latitude N 12^0 7^1 46^{11} to$12^0 5^1 01^{11}$ and LongitudeE 7^o 40^1 $8^{11}$to $7^o 49^1$ 55^{11}. Musawa is in the southern part of Katsina State and bounded to the north by Dan Musa, Matazu and Kankia Local government areas. To the east by Kano state, to the south by Mulumfashi local government area and to the west by Kankara local government area.

The area is very accessible from various motorable road and, foot paths to thesurvey sites.

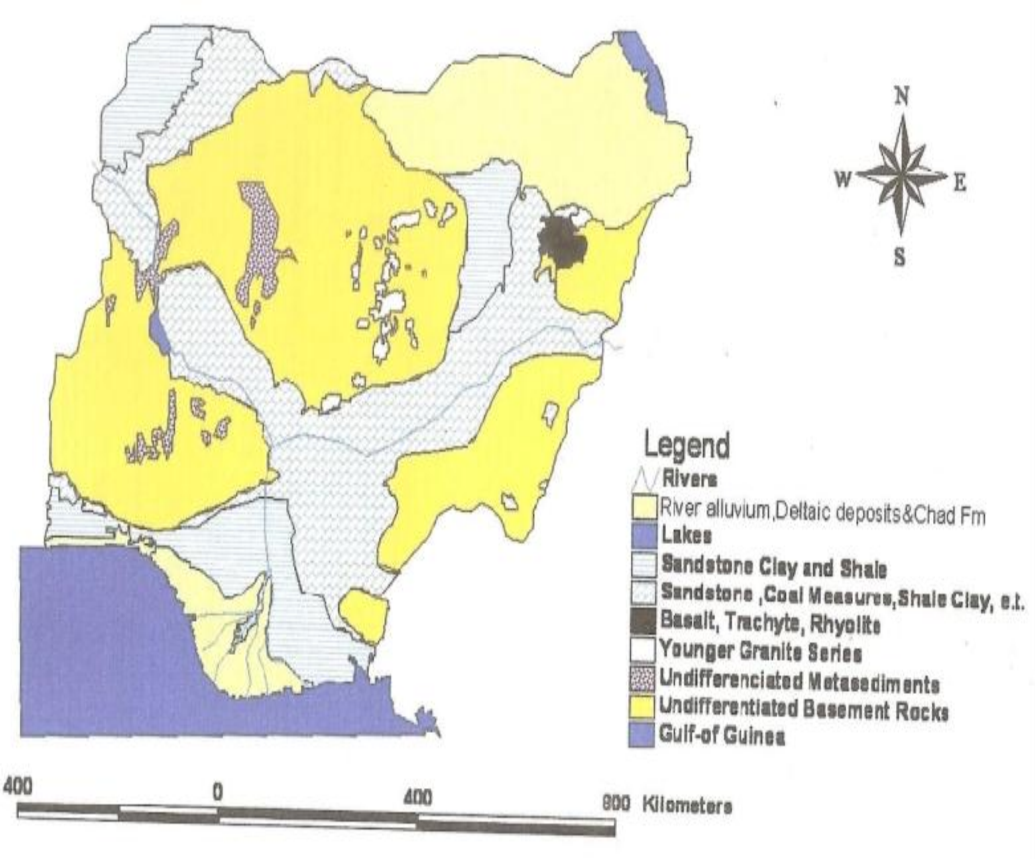


Fig 1. A simplified geologic map of Nigeria

III. Geologyand Hydrogeology Of The Study Area

The geology of the study area comprises the following rock units; migmatite-gnesis,metavolcanics, granites, igneous rocks (Ibrahim 2010a). Parts of the state are underlain by granites with ion capping in some of them. There are also the Daura igneous complex rocks and the Gundumi and Chad sedimentary formations (Kogbe, 1975).

Outcrops consist almost entirely of resistant migmatites, quartzites, conglomerates and granites, although there are small exposure of softer gneisses and semi-pelitic rocks in some stream channels. Rocks of the migmatite- gneiss basement complex constitute the majority in real extent (McCurry, 1970).

The hydrological setting of the study area is typical of any basement complex terrain and ground water in such terrain is usually found in the fractured zones and weathered basement. Occurrences of groundwater are rather shallow and its movement is controlled largely by topography. At bedrock depressions in a typical basement complex just like in the study area in Nigeria are groundwater collecting centers. Consequently, the groundwater flows away from the crust of the basement ridges into bedrock depressions (Ariyo, 2005)

The study area is well drained by a network of rivers and streams, such river Doma and river Magogie and their tributaries drained in to river Fatsa. At the northeast, river Gagare and its tributaries drained (flows) northwest. At the southeast, river Jare and river Gora along with their tributaries drained eastward. However all the seasonal rivers systems that contain water in their channels only during the rainy season, with little or no water in the dry season.

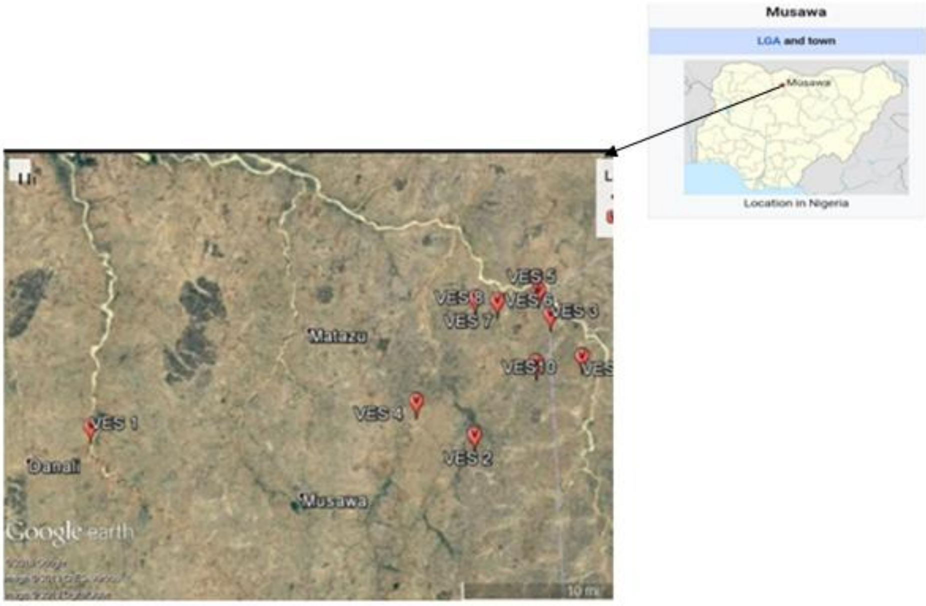


Fig 2. Google map of the study area

IV. Methodology

Electrical resistivity survey involving vertical electrical sounding (VES) method was adopted. The technique is one of the methods employed for groundwater exploration using OhmegaTarrameter with schlumberger configuration. The method used in the delineating of bed rock structures, depth to possible aquifer units and infer the ground water potential of the basement complex area. By performing a vertical electrical sounding (VES) a linear electrodes array is laid out injecting a direct or a slow alternating current into the ground. In the center the voltage response is measured simultaneously between two electrodes. Increasing depths are realized by enlargement of the current electrodes from very small distance in the beginning to larger distances at the end of the array. In the schlumberger array, potential electrodes remain temporally fixed while greater depths are probed by expanding the current electrodes expanded symmetrically along the center of the array.

V. V.Results

VES1

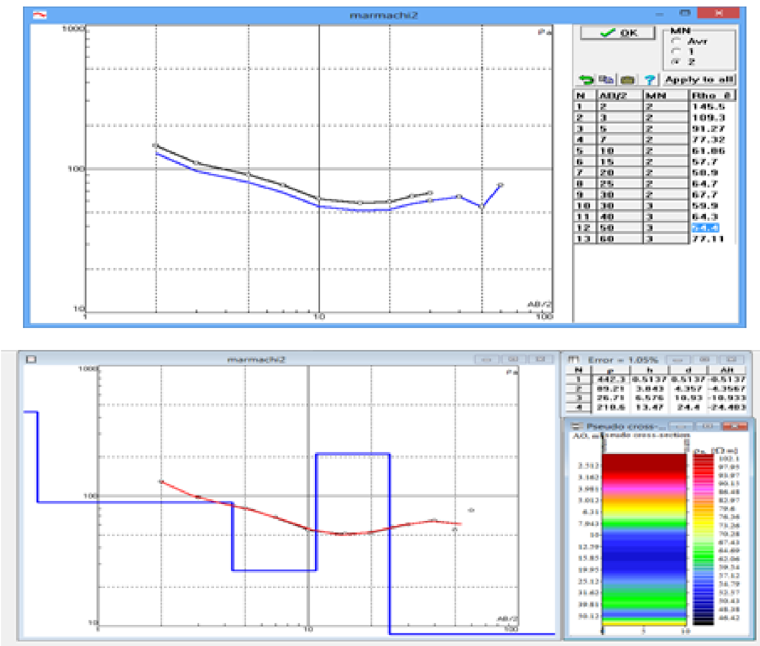


Fig 3. VES 1

Table 1.VES 1 Result

Layer No	Pa (Ω/m)	Geo-electric section	Depth(m)
1	442.3	Topsoil	1
2	89.21	Consolidated sandstone	10
3	26.71	Fracture basement	30
4	210.6	Fresh basement	60

VES2

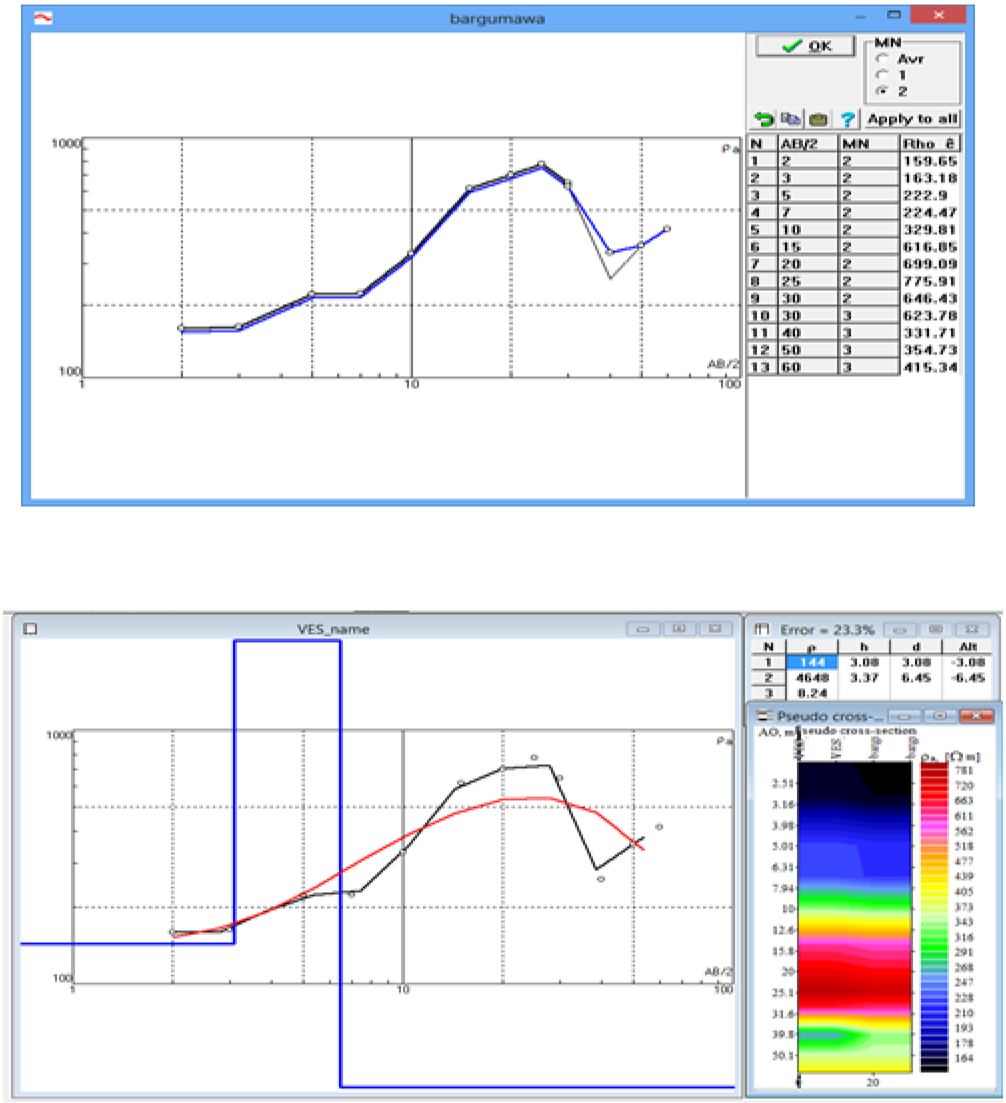
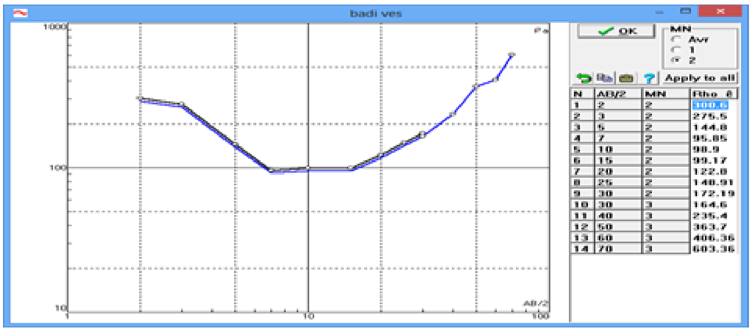


Fig4: VES 2

Table2. V ES 2 Result

Layer No	Pa (Ω/m)	Geo-electric section	Depth(m)
1	144	Topsoil	1
2	46	Consolidated sandstone	6
3	8.24	Fresh basement	60

VES3



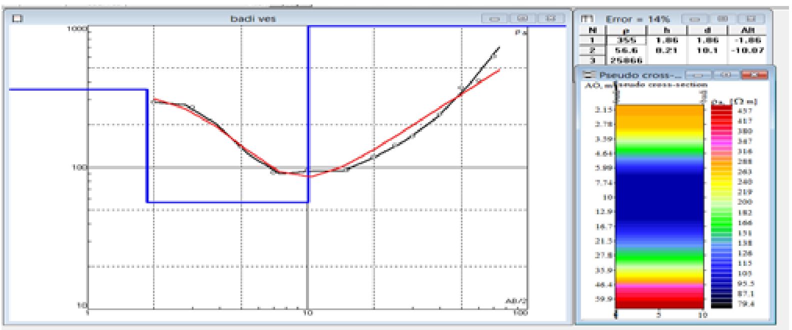
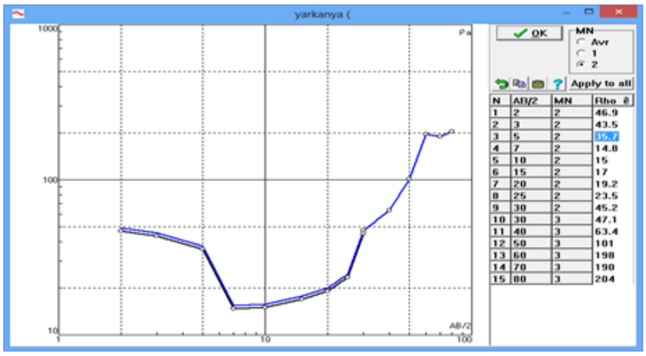


Fig5: VES 3

Table3VES3 Result

Layer No	**Pa (Ω/m)**	**Geo-electric section**	**Depth(m)**
1	355	Topsoil	1
2	56	Consolidated sandstone	30
3	25866	Fresh basement	60

VES4



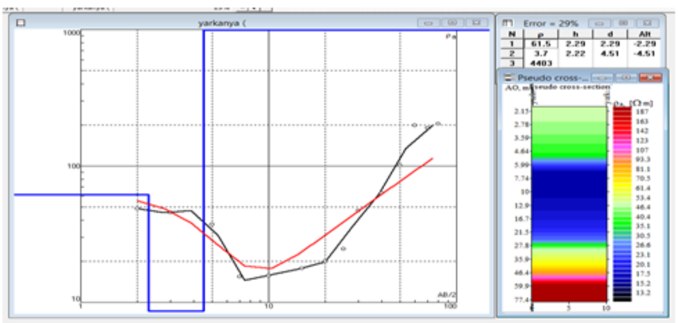
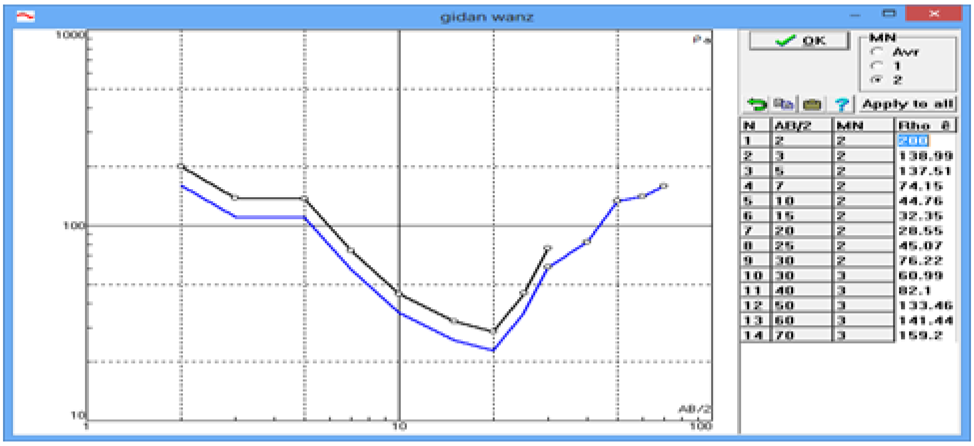


Fig 6.VES4

Table 4.VES4 Result

Layer No	Pa (Ω/m)	Geo-electric section	Depth(m)
1	51	Topsoil	1
2	3.7	Fracture basement	30
3	4403	Fresh basement	80

VES5



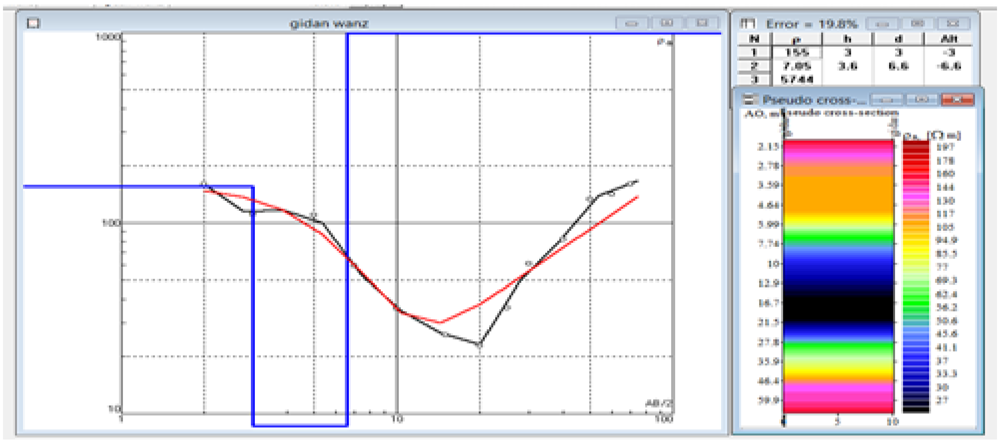


Fig7. VES 5

Table5VES5 Result

Layer No	Pa (Ω/m)	Geo-electric section	Depth(m)
1	155	Topsoil	1
2	7.05	Weathered basement	30
3	5744	Fresh basement	70

VES 6

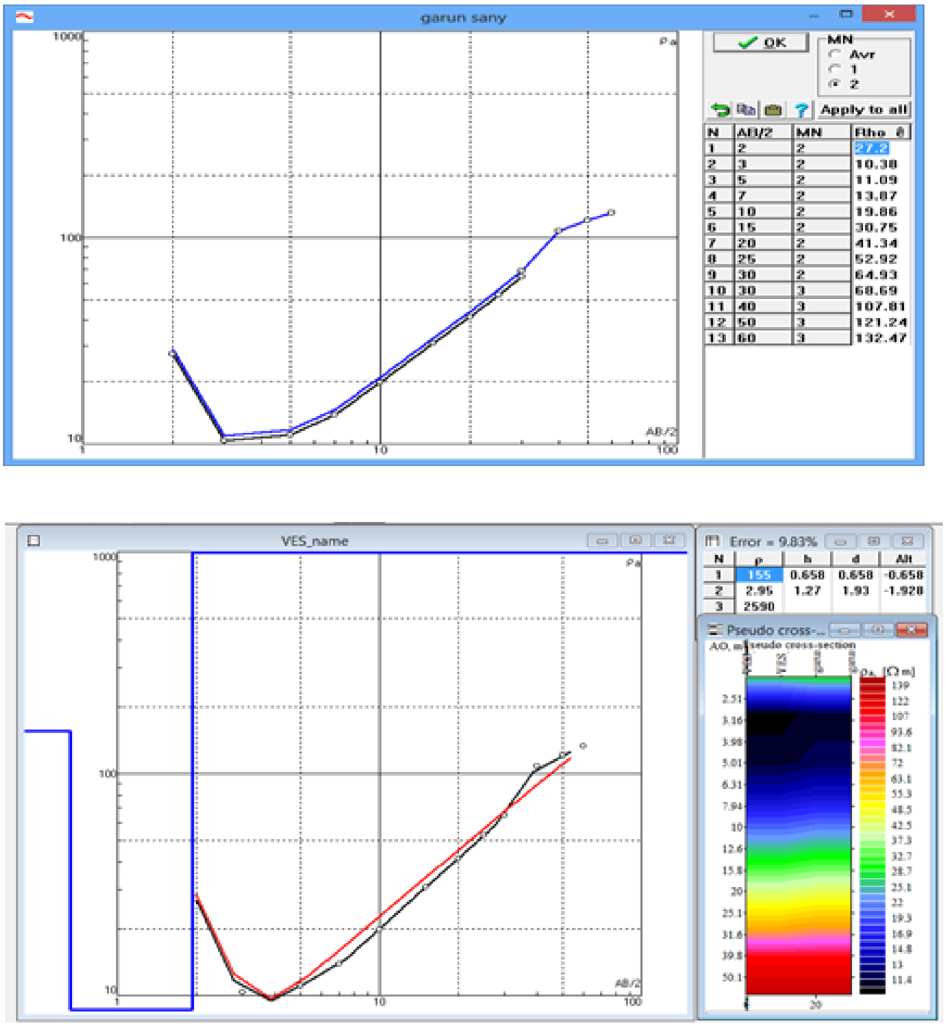
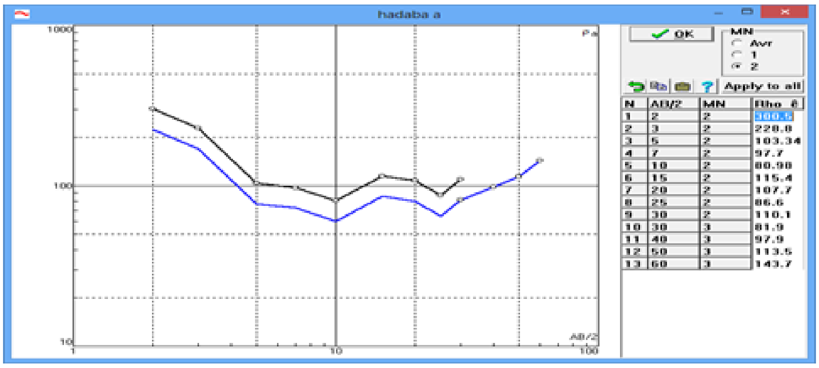


Fig8. VES 6

Table6VES6 Result

Layer No	Pa (Ω/m)	Geo-electric section	Depth(m)
1	155.9	Topsoil	1
2	2.95	Fracture basement	30
3	2590	Fresh basement	60

VES7



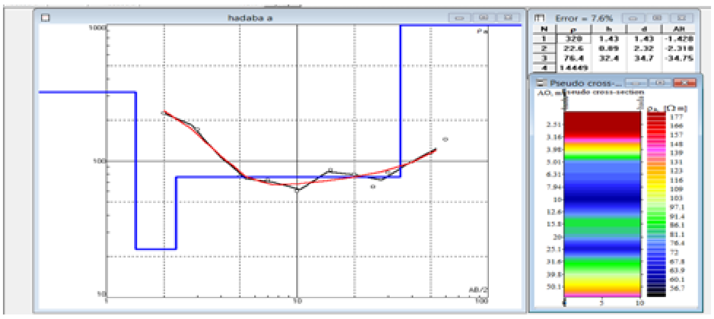
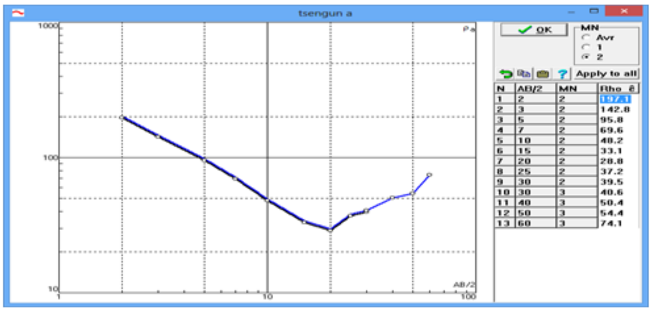


Fig 9. VES7

Table7VES7 Result

Layer No	Pa (Ω/m)	Geo-electric section	Depth(m)
1	320	Topsoil	1
2	22.6	Clay	6
3	76.4	Fresh basement	30
4	14449	Fresh basement	60

VES8



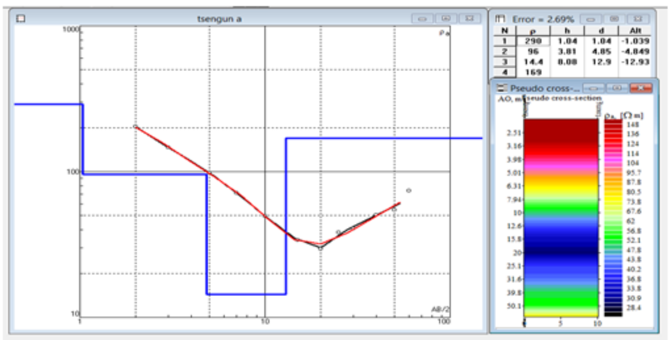
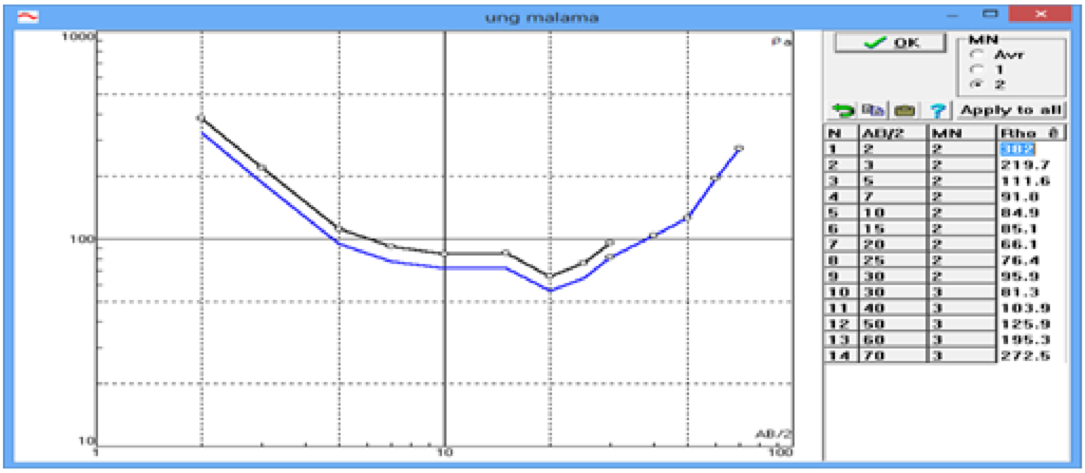


Fig 10. VES 8

Table 8.VES 8 Result

Layer No	Pa (Ω/m)	Geo-electric section	Depth(m)
1	290	Topsoil	1
2	96	Consolidated sandstone	6
3	14.4	Fracture basement	30
4	169	Fresh basement	60

VES9



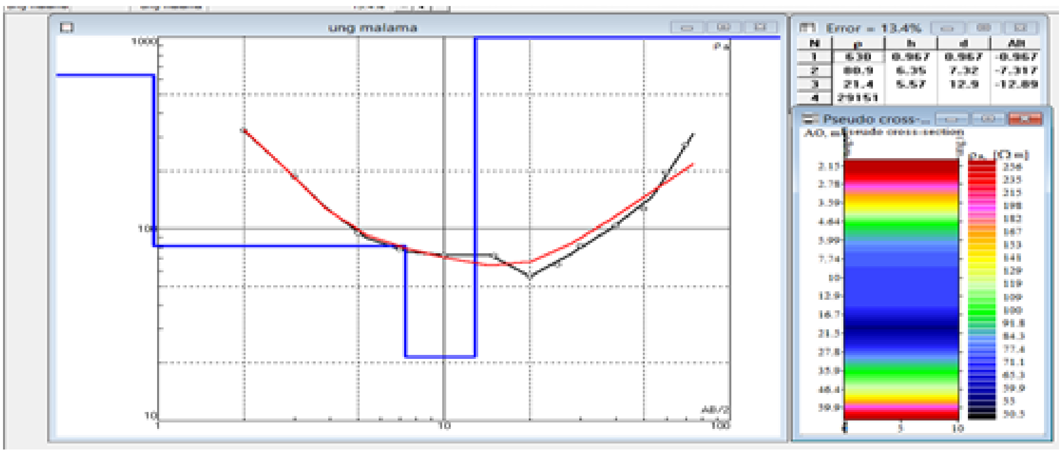
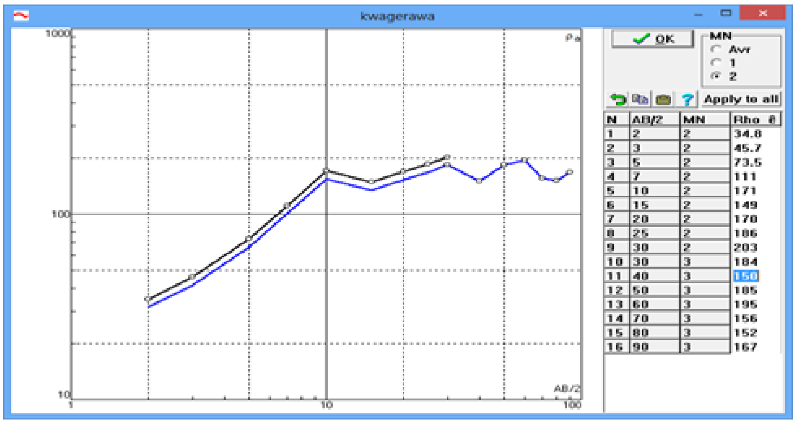


Fig 11. VES 9

Table 9.VES 9 Result

Layer No	Pa (Ω/m)	Geo-electric section	Depth(m)
1	630	Topsoil	1
2	80.9	Consolidated sandstone	6
3	21.4	Fracture basement	35
4	29151	Fresh basement	70

VES10



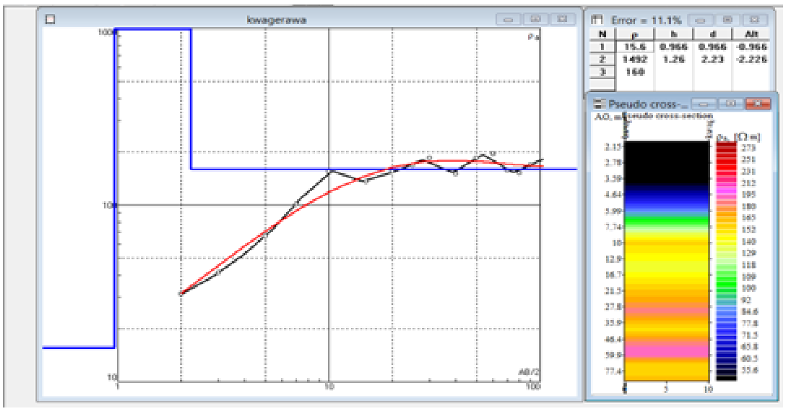


Fig 12.VES 10

Table 10.VES 10 Result

Layer No	Pa (Ω/m)	Geo-electric section	Depth(m)
1	15.6	Topsoil	1
2	1492	Fresh basement	30
3	160	Fresh basement	90

Table11. SUMMARY OF THE RESULTS

LOCATION	VES NO	DEPTH TO GROUND WATER	COORDINATES	RECOMMENDATION
MARMACHI	VES 1	55± 5	N 12°9'46'' E 07°31'43''	May provide groundwater
BARGUMAWA	VES 2	Nill	N 12°9'26'' E 07°46'58''	No fracture/weathered zone
BADI	VES 3	60± 5	N 12°14'8'' E 07°49'59''	May provide good yield of groundwater
YARKANYA	VES 4	58± 5	12°10'45'' E 07°44'39''	May provide good yield of groundwater
GIDANWANZAN B	VES 5	58± 5	N 12°15'3'' E 07°49'31''	May provide good yield of groundwater
GAURUNSANYINA	VES 6	60±	N 12°15'35'' E 07°49'24''	Can provide water
HADABA A	VES 7	Nill	N 12°14'46'' E 07°47'	No fracture/weathered zone
TSEGUN A	VES 8	55± 5	N 12°14'39'' E 07°47'52''	May provide water
UNGMALAMAI	VES 9	58±	N 12°12'29'' E 07°51'14''	May provide good yield of groundwater
KWANGERAWA	VES 10	Nill	N 12°12'15'' E 07°49'25''	No fracture/weathered zone

VI. Discussion Of Results

From the results of 10 VES points that was plotted and smoothened with IP2WIN Software, the following interpretations are as follows;

VES 1, 3, 4, 5, 6, 8, and 9 are H type of curve, which shows potential for groundwater exploration to the depth of of 55-60±5 m, and out of which ves 1, 8, and 9 are interpreted in (Table 1, 8, and 9) and (figure 3, 10, and 11) to have four geo-electric layers. Topsoil, consolidated sandstone, fracture basement and fresh basement while VES 3,4, 5, and 6 are interpreted in (Table 3, 4, 5, and 6) and (figure 5, 6, 7 and 8)to have three geo-electric layers. Topsoil, consolidated sandstone, and fracture basement.

VES 2 is a H-K type of curve and it shows no potential for groundwater exploration. It is interpreted in table 2 and figure 4 to have three geo-electric layers. Top soil, consolidated sandstone and fresh basement.

VES 10 is a k type of curve and it shows no potential for groundwater exploration and it is interpreted in table 10 and figure 12 to have three geo-electric layers. Top soil, fresh basement and fresh basement.

Further more, out of the ten ves points that was investigated three points which includes, ves 2,7, and 10 shows no potential for groundwater exploration.

VII. Conclusion

This work was carried out based on the principles of resistivity survey which is a method of geophysical exploration that probe subsurface rocks using there geo-electric properties. Ten VES stations was investigated for this research out of which 7 VES points have shown groundwater potentials which includes VES 1 (Marmachi),3 (Badi),4 (Yarkanya),5 (Gidanwanzan),6 (GaurunSanyina),8 (Tsegun),9 (UNG Malamai) at the depth of 55-60±m, while VES 2 (Bargumawa), 7 (Hadaba), and 10 (Kwangerawa) have shown inadequate groundwater potentials, and after a successful drilling of the seven VES stations with groundwater potentials; it has finally come to conclusion that about 70% of the VES points are groundwater potential areas.

Acknowledgement

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