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Geophysical Investigation of Ground Water Potential in Basement Terrain, Okene North Central, Nigeria

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Abstract
This study was carried out to investigate the ground water potential in some selected locations in Ageva, Okene district of Nigeria. A total of 8 vertical electrical sounding was conducted using the Abem Terrameter (SAS 1000).The data obtained were subjected to interpretation by partial curve matching and then by computer iteration and the result correlated with records from existing wells. A total of 4 geoelectric layers namely: top soil, weathered layer, sandy clay Fresh basement was delineated in this study. The depth to aquifer was obtained between 5.0 to 18.0 m from the surface. While the resistivity of the aquifer ranged between 33.0 to 273 Ωm. The area is a high ground water potential especially since there is thick overburden and highly fractured basement in the subsurface.
Keywords: *Ground water, geoelectric section, terrameter, vertical electric sounding.*

Introduction

Groundwater is valuable natural resources but sometimes is also a major hazard in engineering works which may require expensive remedies to contain their presence in soils or rocks. On the positive side, groundwater pumped from wells is put to domestic and industrial uses. It provides a convenient barrier to contain hydrocarbons i.e. petroleum and natural gas in underground storage chamber, e.t.c. Furthermore, groundwater has the capacity to dissolve and transport contaminants which may enter producing aquifers.

The rapid increased in population in Ageva in particular and Okene local Government Area in general in addition to agricultural practices have put high demand on portable water at an alarming rate. So, surface water is unable to cope with the ever increasing demands and the only alternate source of perennial water supply is the ground water and these necessitate the construction of boreholes for individual uses. Singh (1985) is of the opinion that large scale development of groundwater depends on reliable estimate of groundwater potential of the area.

This is possible by a systematic exploration program using modern scientific tools. The geophysical methods provide reliable information with respect to distribution, thickness and depth of groundwater bearing formation. The most commonly used geophysical technique in Nigeria is the electrical resistivity method because of its low cost and relatively high reliability.

Geology of the study Area

Ageva is a part of Okene local government. Okene lies within the North Central Basement Complex of Nigeria. The Basement Complex rocks of lower Palaeozoic to Precambrian ages underlie about half of the entire landmass of Nigeria. These rocks are represented by gneiss-migmatite and intrusive into these basement rocks are the Pan-African granite (Turner, 1971) The study area is characterized by the following rock types: older granites of Pan African age, highly weathered migmatites gniess, melanocratic banded gneiss with faults of various orientations that dips between 45^0 to 85^0.

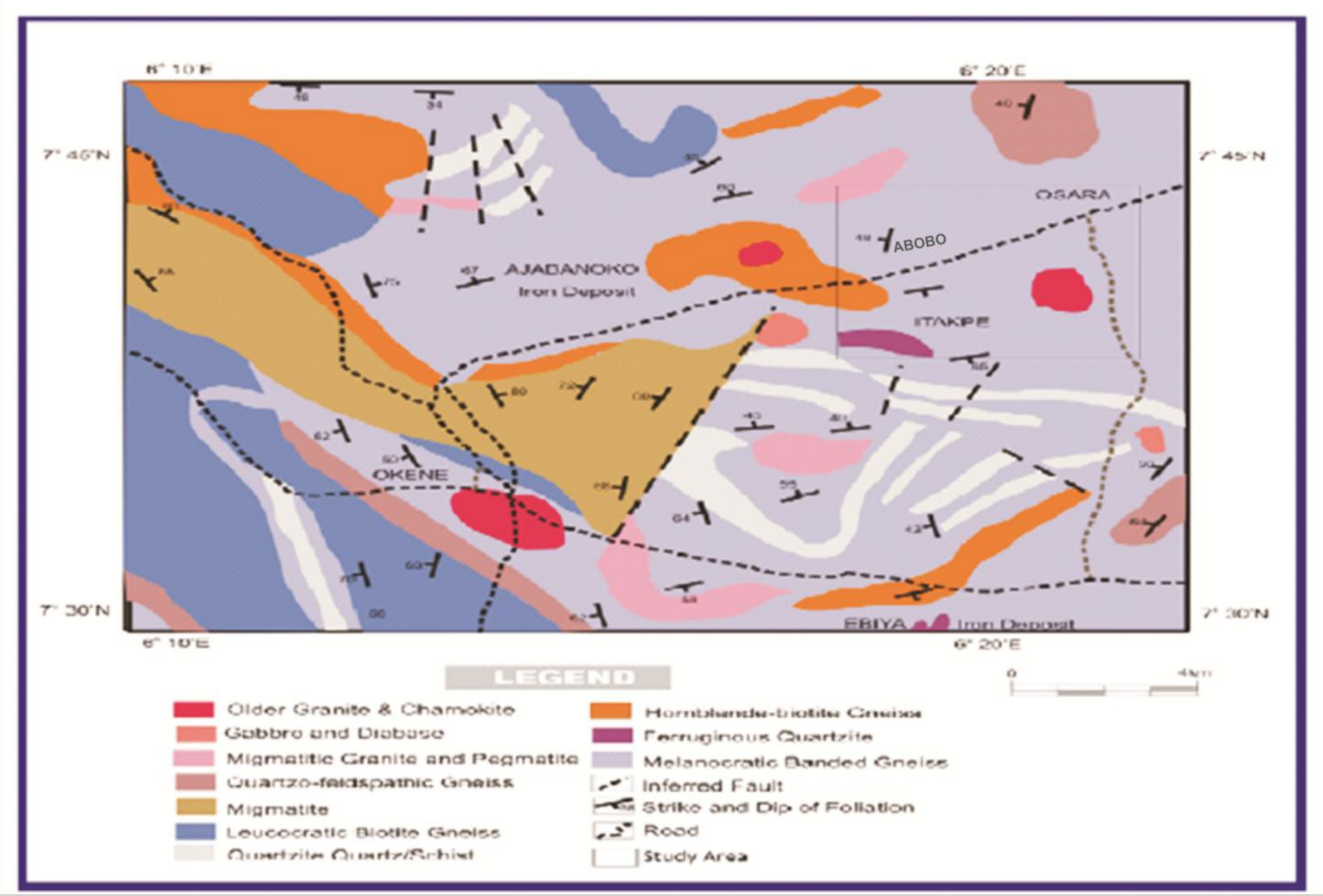

Fig. : Geology of the study Area

Materials and Method

The study area, Ageva lies within Okene, and is located in the North central part of Nigeria; this area is hilly and undulating and is accessible by roads and foot paths.

The Study Area covers about 5 km^2 and is investigated using vertical electrical sounding and schlumberger array was adopted by using PASI (P-100Nx) Terrameter and its accessories including G.P.S. for the study.

A total of 8 vertical electrical sounding were carried out in the are using PASI (P-100NX) Terrameter. The schlumberger electrode array was employed for vertical electrical sounding. Measurement were done by expanding the current electrode distance and the potential electrode was kept constant but changed only when the reading become too small to be accommodated by the instrument's sensitivity. The values of the apparent resistivity obtained were plotted against current electrode spacing using a log – log graph paper. The field data were first curved match and the result is subjected to computer iteration soft ware to obtain the layers true resistivity and thickness.

Results and Discussion

Results

The summaries of vertical electrical sounding results are presented in table 1and the field curves in fig.1to 8 which are predominantly four layered H type curves. In addition the geoelectric section is presented in fig. 9

The Top Soil: The first layer is the top soil and it is a mixture of laterite and sand and its thickness ranges from 1.0 to 2.7 m with resistivity 350.0 to 3,396.3 Ωm and depth varies from 1.0 to 2.7 m.

The Weathered Layer: The second layer has sandy clay as the main material, its thickness ranges from 2.0 to 26.5 m and the depth of this formation varies from 3.9 to 28.4m with resistivity of 40.6 to 292.6 Ωm.

The Fractured Layer: The third layer is either partly weathered or fractured. The apparent resistivity of this layer ranges from 32.6 to 67.8 Ωm and the depth range from 10 to 18 m.

The Fresh Basement: The fourth layer is the final layer in the subsurface. It has the highest resistivity of 1189.4 – 3093.4 Ωm, we may be approaching the fresh basement. The thickness and depth of this layer are not quantified.

VES NO	Resistivity Ωm	Thickness (m)	Depth (m)	Layers	Curve Types	Characteristic of Layers
1	781.5 130.7 46.4 -	2.1 2.6 9.9 -	2.1 4.6 14.5 -	4	H	Top soil Weathered materials Fractured rock Fresh Basement.
2	1193.8 292.6 67.6 3093.4	1.0 4.9 12.6 -	1.0 5.9 18.5 -	4	H	Top soil Weathered materials Fractured rock Fresh Basement.
3	350.6 89.7 729.7	1.4 3.6 -	1.4 5.0 -	3	H	Top soil Weathered Materials Partly weathered Basement.
4	2793.2 86.3 463.0	2.0 26.5 -	2.0 28.4 -	3	H	Highly resistant top soil. Weathered materials Partly weathered Basement.
5	660.7 224.2 32.6 1189.4	2.7 1.2 10.4 -	2.7 3.9 -	4	H	Top soil Weathered materials Fractured rock Fresh Basement.
6	3396.3 107.4 768.8	2.1 17.1 -	2.1 19.3 -	3	H	Highly resistant top soil. Weathered materials Partly weathered Basement.
7	836.2 40.6 1326.7	2.9 15.5 -	2.0 17.5 -	3	H	Top soil Weathered materials Fresh Basement.
8	504 133.4 276.2	1.5 8.3 -	1.5 9.8 -	3	H	Top soil Weathered materials Partly weathered Basement.

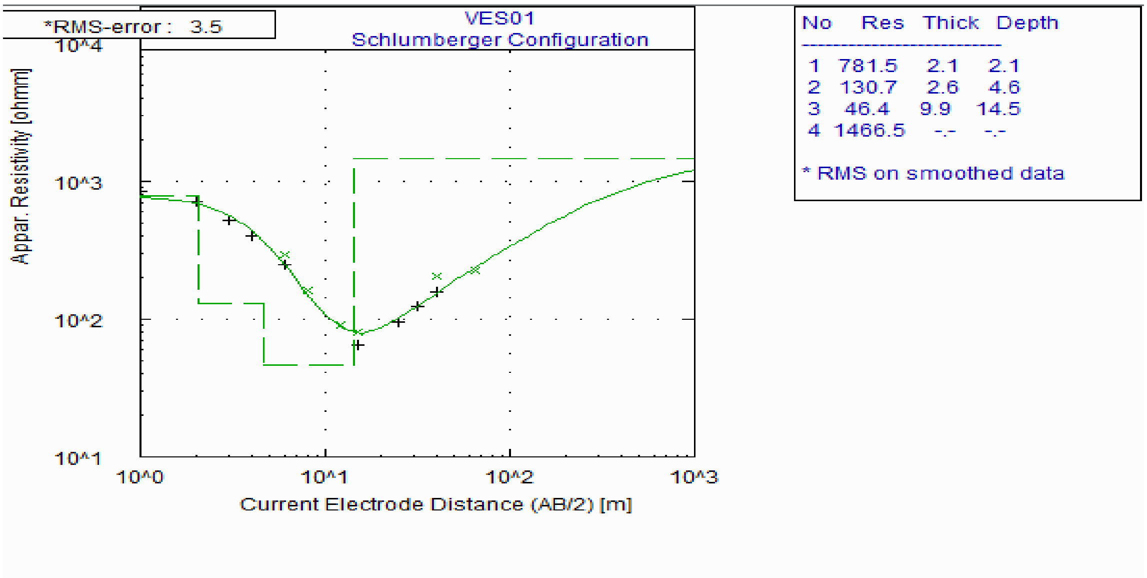

Fig.1: Computer inverse modelling for the Data obtained at Ageva (VES 1)

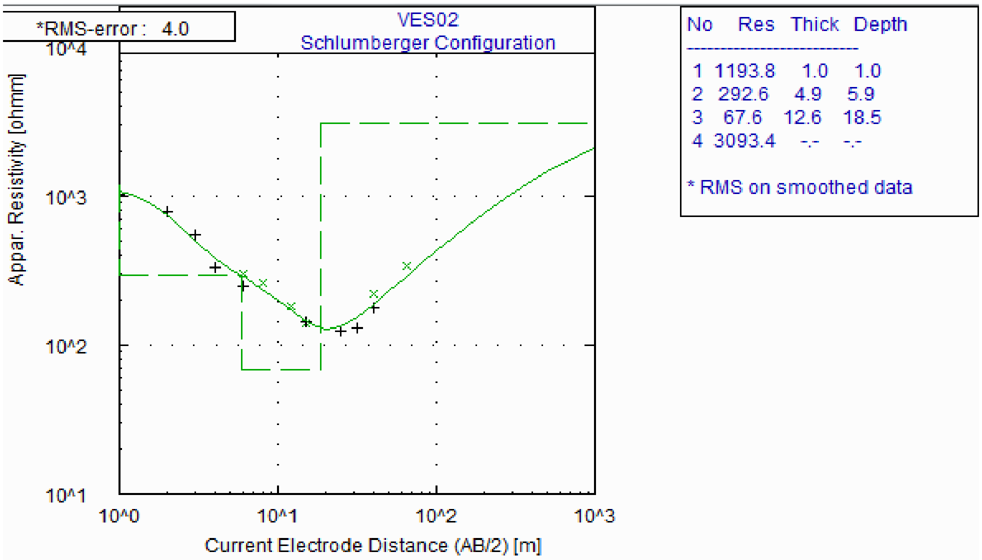

Figure 2: Computer inverse modeling for Data obtained at Ageva (VES 2)

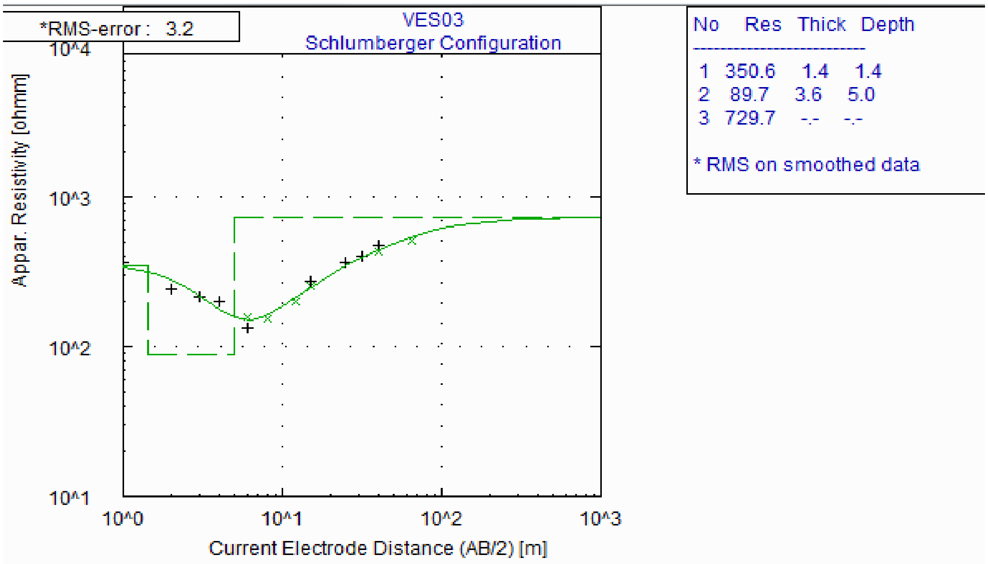

Figure 3: Computer inverse modeling for Data obtained at Ageva (VES 3)

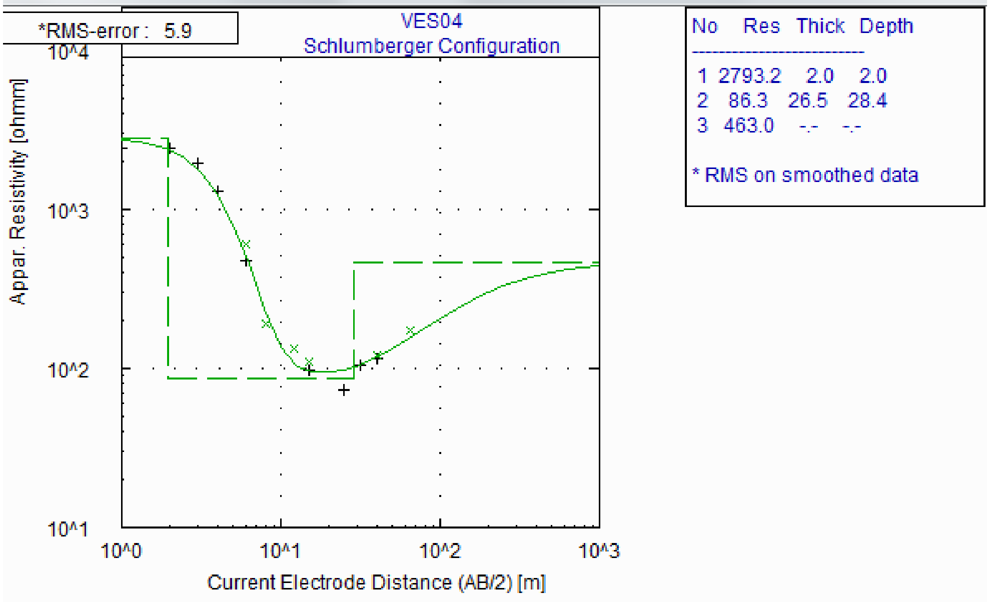

Figure 4: Computer inverse modeling for Data obtained at Ageva (VES 4)

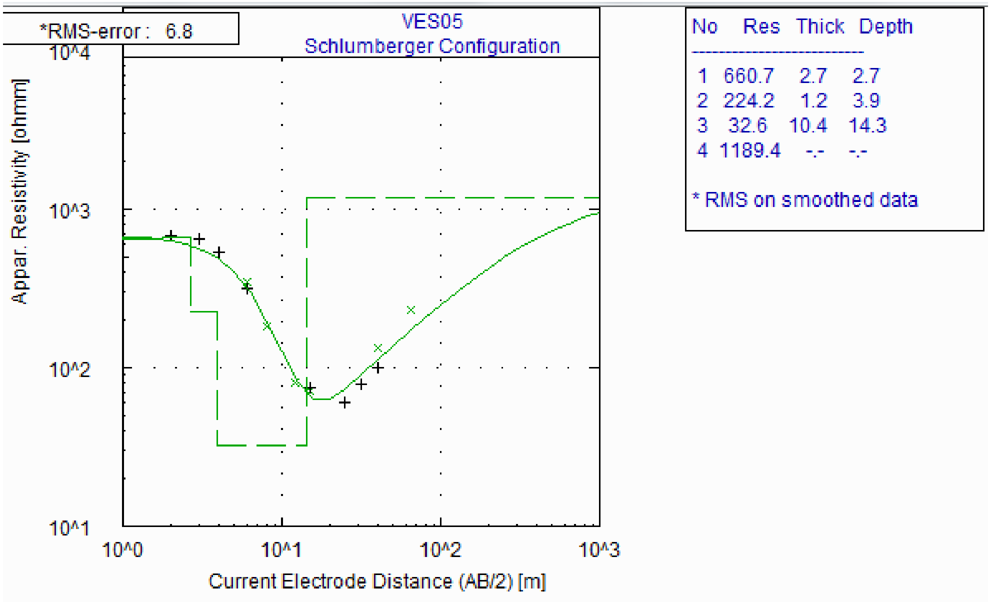

Figure 5: Computer inverse modeling for Data obtained at Ageva (VES 5)

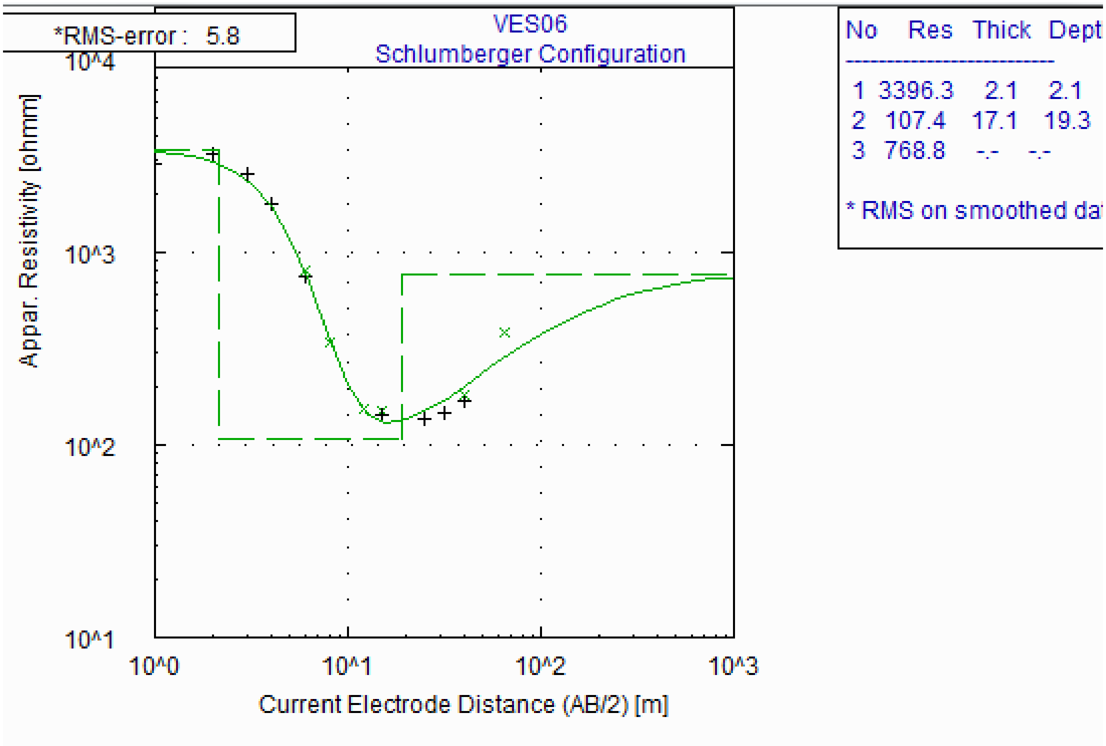

Figure 6: Computer inverse modeling for Data obtained at Ageva (VES 6)

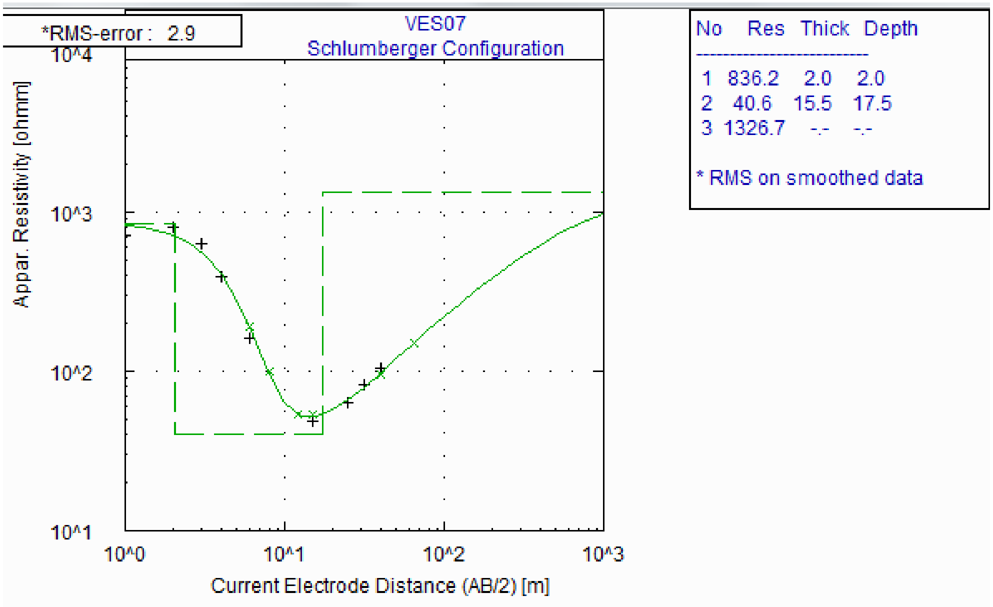

Figure 7: Computer inverse modeling for Data obtained at Ageva (VES 7).

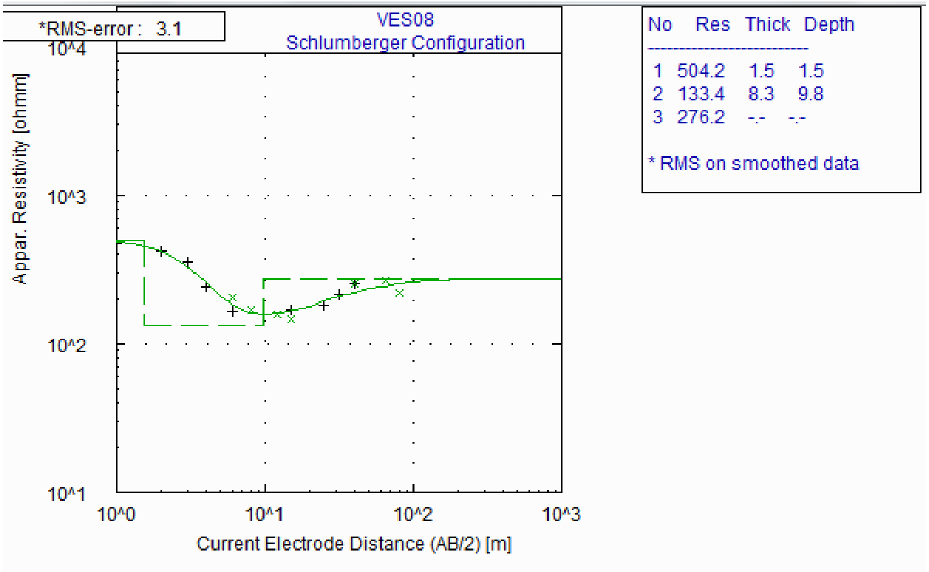

Figure 8: Computer inverse modeling for Data obtained at Ageva (VES 8)

Geoelectric Section

The geoelectric section of the area is shown in fig.9 and it is delineated into four layers: the top soil, weathered materials, fractured rock and the fresh basement.

Top soil

This is the first layer and its resistivity range from 504 to 3396 Ωm. This layer is mainly sandy to lateritic in nature. Its thickness varies between 1 to 2.7 m. This layer has no any hydrogeological characteristics and it is not an aquifer.

Weathered Layer

This is the second layer of the geoelectric profile. The resistivity of this zone varies from 41 to 293 Ωm with an average thickness of 3.8 m.The highest thickness is delineated under VES 4.This layer is highly significance especially in area where it is thick enough and equally saturated with water.

Partially weathered/Fractured Basement

VES 1,3,5 are delineated fracture zones. The thickness of this zone varies from 2.0 to 5.0 m. These zone have the lowest overburden thickness of 5.0 m which is the smallest among all the layers. The resistivity of these zone varies from 33.0 to 68.0 Ωm. The layer constitute the major aquifer unit in the study area.

Fresh Basement

The fresh basement rock is the last layer with resistivity values of 1327 to 3093 Ωm and to infinity. This zone does not have hydrologic property because of the crystalline nature.

Conclusion

In this study, the ground water prospect of rock units in Ageva quarter of Okene, North – central Nigeria was under taking Schlumberger Vertical Electrical Sounding (VES). The curve type is H – type of curve. The computer iterated sounding interpretation reveal four subsurface sequences comprising: top soil with limited hydrologic significance, weathered/ fractured basement rocks with low resistivity which constitute the major aquifer units in the area, the yield depend on the degree of clay content. The higher the clay content, the lower the ground water yield potential.

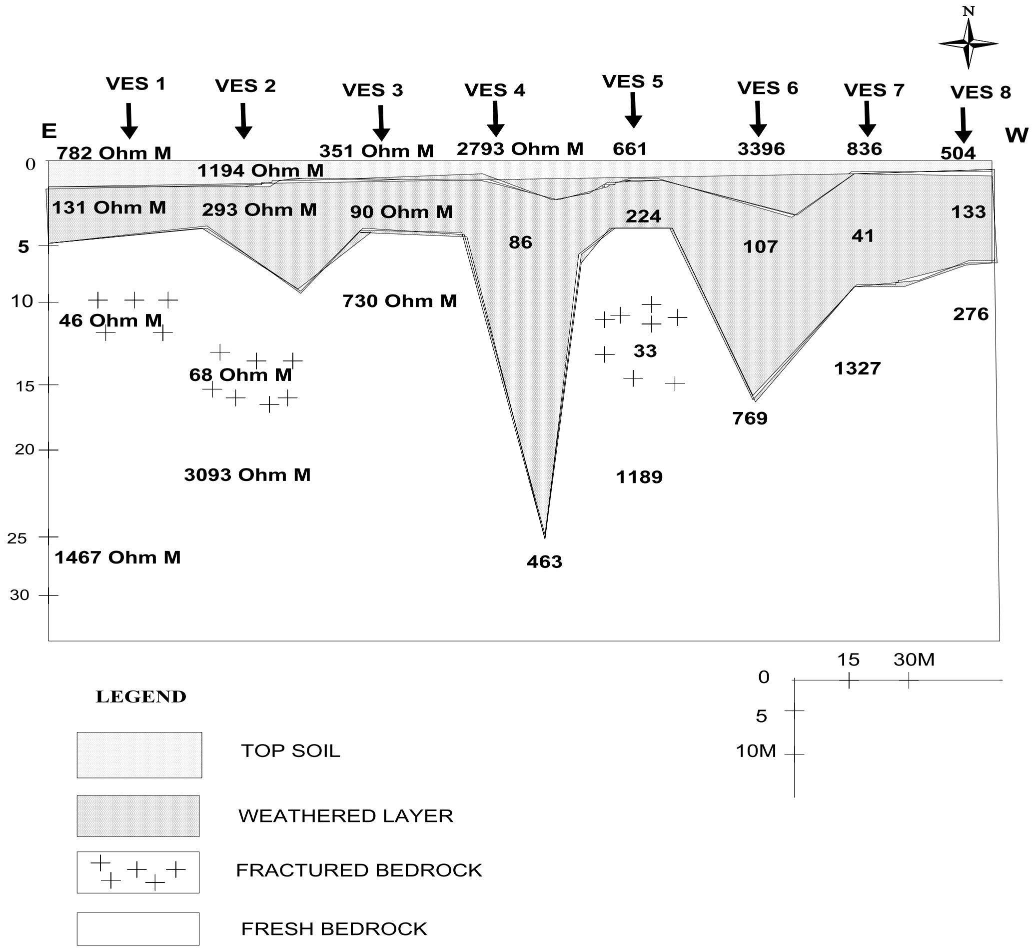

Fig. 9: Geoelectric Section

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