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Geophysical Investigation of Weathered Basement, Using Electrical Resistivity Method in Zainawa Village, Kano State, Nigeria

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ABSTRACT

The type of method adopted for this research was the 1D electrical resistivity, using the GEOPULSE Tarrameter. A schlumberger configuration was carried out to map out the Geological features of the earth subsurface. Five profiles were carried out in the study area. Each profile, the layout geometry for the electrical resistivity were the normal schlumberger arrays. The maximum current electrode separation (AB) was 200m, that is, AB/2=100m. The data obtained using Geopulse resistivity Meter SAS 300 were processed using computer software (IPI2Win).

Based on the electrical resistivity value obtained in the study area, the following deductions were made.

The average depth to the fresh basement is generally beyond 30m. The target area revealed the presence of two distinct layers, the top soil and weathered basement with resistivity range of 20-782Ωm and 100-978Ωm respectively. These layers constitute the overburden with a thickness of 2.1m. The weathered basement underlies the topsoil with an average thickness of 18m and this is a good aquifer in the target area. The depth of probing which is 30m above the fresh basement.

KEY WORDS: *Vertical electrical sounding, Zainawa, Geoelectrical section, Resistivity, Aquifer, Alluvial.*

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I. INTRODUCTION

The purpose of electrical surveys, is to determine the subsurface resistivity distribution by making measurements on the ground surface. From these measurements, the true resistivity of the subsurface can be estimated.

Exploration for ground water involves the use of various methods applied in the location of water bearing rocks called aquifers. Among the most common aquifers are consolidated sands and gravel of alluvial, glacial, sedimentary rocks especially limestone, dolomite, sandstones, porous or fractured volcanic. Pressure on natural resources from growing populations, with increase demand for water supply for domestic use, infrastructure and housing has increased geometrically over the past decades and can be expected to rise continually. Further, stress on the environment due to population surge and pollution will increase the need for detailed geological knowledge, for geotechnical, hydrogeological and environmental protection purposes. Geophysical methods can play an important role in the acquisition of such knowledge. However, the complete survey procedure, including the data acquisition, data processing, interpretation and presentation must be efficient in terms of time, cost and manpower.

Huge amount of money is being spent yearly in Nigeria both federal government and state government for sinking boreholes in other to reduce the perennial scarcity of water to the bearest minimum yet no meaningful result, erosion control and host of others, yet this amount do not justify the work as soon after, the boreholes fails and pollution of ground water continues and erosion is now moving at an alarming speed toward the northern part of the country. This can be effectively managed and controlled if only there is a proper geophysical mapping of the target area. Different lithologic material constitutes majorly the basement complex and sedimentary aquifers. The basement aquifers in the study area are fractured rocks and the weathered in-situ material while the sedimentary aquifers consist of sands and sandstones.

II. GEOLOGY OF THE STUDY AREA

The study area (Latitude 12° 36ˈN and Latitude12° 46ˈN; and Longitude 08° 26ˈE and Longitude 08° 65ˈE) lies within the basement complex of Northern Nigeria. The rocks within this basement complex are grouped into four categories; these are the older Granites, older Metasediments, younger Granites and younger Metasediments. According to McCurry, (1976), the Northern Nigerian basement complex are believe to have occurred in at least four orogenic episode namely: the pan African (600±150My), the Kibaran (1100±200My),the Eburnean (2000±200My) and the (2800±200My) orogenies.

SITE AREA DESCRIPTION

Figure 1 shows the location of the study area. Zainawa village is situated in Gazewa local government area of Kano State 18Km south east of Jigawa State. The mean altitude of the area is about 600m above mean sea level. Accessibility to the Zainawa village is only by the Kano-Jigawa road which is prominent federal road.

METHODOLOGY

Electrical geophysical survey involving vertical electrical sounding (VES) was carried out using Campus Geopulse SAS 300 terrameter on the study area. The vertical electrical sounding was carried out along five profiles created, each measuring 500m at a separation of 100m. 30 vertical electrical soundings spaced at a station of 70 metres were carried out on each profile. A maximum current electrode spacing (AB) of 200m was used. A current variation in the range of 0.2-1.0A, found suitable in the basement terrain (Badmus et al.,2005), was used in the survey.

DATA ANALYSIS AND INTERPRETATION

The geophysical data interpretation involves expressing the information obtained from the survey measured into geological section or geoelectric section, from which both qualitative and quantitative deduction are deduce from. An exclusively quantitative interpretation of apparent resistivity data is often difficult because of wide variations in resistivity possessed by geological materials and the difficulty in developing theoretical expressions for apparent resistivity`s of all but the simplest geometries (Burger and Burger.,1992).The apparent resistivity values at each sounding point have been calculated from the resistance values recorded on the field and the geometric factor used for the layout. The apparent resistivity calculated are presented as sounding curves for all the VES points using IPI2Win, a software designed for interpreting vertical electrical sounding data (Bobachev, 2001).

Typical graph obtained from the field along with their model are shown in figure 2a, 2b, 2c, 2d . Apparent resistivity (pa) in ohm-meters is plotted against the electrode spacing (AB/2) in meters by the computer software IPI2Win on log-log scale. The blue colour gives the number of layers, The red colour indicate the calculated curve while the black colour gives the observed curve for the field data. The geoelectric and geologic section are obtain from the graph for the five profile as it was shown in figure 3,4,and 5. Four subsurface lithological layers are distinguished, this comprises of top soil, weathered layers, partly weathered/ fractured basement and fresh basement. The top soil has resistivity ranging from 20-161 ohm-metre with an average thickness of 2.5m. This layer consists of laterite, clay and silt Three geoelectric section was observed that the top soil has a low resistivity values ranging between 20-44 ohm-metres this is as a result of clay present in the top soil. Underlying the top soil is a formation between VES 3,4,9,10,15,16 and 20 where the resistivity is between 24-64 ohm-metre and average thickness of 9m. It indicates a high degree of saturation, it shows that the layer correspond to aquiferous layer zone in the study area. The resistivity values of the third layer range from 746-1046 ohm-metre, this layer is partially weathered/fractured basement. The weathering action that take place within the layer is due to the presence of fractures. The fourth layer of infinity thickness has a resistivity greater than 500 ohm-metre, this layer is probably the fresh basement. The groundwater in the study area mostly located in the weathered basement layer and weathered/fractured layer basement, this study suggest that the water level is closed to the surface. The table 1 shows the thickness of overburden, the depth to the weathered layer and the fresh basement.

III. CONCLUSION

From finding in this research the geoelectric sections for profile A and B suggests that the area is underlain by rocks of different lithological compositions, namely: top soil consists of laterites, clay and fadama loam, weathered basement (sandy), fractured and fresh basement rocks. The information obtained from the geoelectric section such as: depth to basement, aquifer thickness led to conclusion that VES points 02,03,05,07,11,16,21,22,23,25,26,27 and 30 have the greatest groundwater potentials in the area and are suitable for dug well and borehole development. VES point 05,22,23 and 25 fall on the linear region of the basement depression . Also the thickness of the weathered/fractured basement beneath the region was found to be considerable large.

IV. ACKNOWLEDGEMENT

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REFERENCES

[1.] Ameloko A.A., (2006). Two-dimensional imaging over the western part of Kubanni River Basin, Zaria, Nigeria. An unpublished M.Sc. thesis, Department of Physics, Ahmadu Bello University, Zaria.

[2.] Badmus, B.S., Ayolabi, E.A., Olowofela, J.A., Adisa, S.A., and Oyekunle, T.O. (2005). Current variation in Electrical Resistivity probing using wenner and schlumberger Arrays in a basement terrain. Journal of Geophysics. Eng.2,118-125

[3.] Bobachev A.A. (2001). IPI2Win users guide. Moscow State University, Geological Faculty, Department of Geophysics. Geoscan-M.Ltd.

[4.] Esse, O., Oyedele, K.F., Ogagaurue D.O.,(2011). Groundwater potential evaluation using surface Geophysics at oru-Imope, Southwestern Nigeria. European journal of scientific research, ISSN 1450-2160 Volume 63 no 4 pp515-522.

[5.] Gholam R.L and Nad M.N., (2005). Geoelectrical investigation for the assessment of groundwater condition: A case study of Annals of Geophysics volume 48 no 6 pp937-944.

[6.] Kumar, D., (2008). Assessment of natural groundwater recharge in upper Ganga Canal Command Area. Journal of Application of hydrol vol.15(4), pp13-20.

[7.] McCurry, P., (1976). The geology of Precambrian to lower peleozoic rock of northwestern Nigeria. A review in Kogbe. C.A. (Ed), Geology of Nigeria. Elizabeth publishing Company Lagos pp15-39.

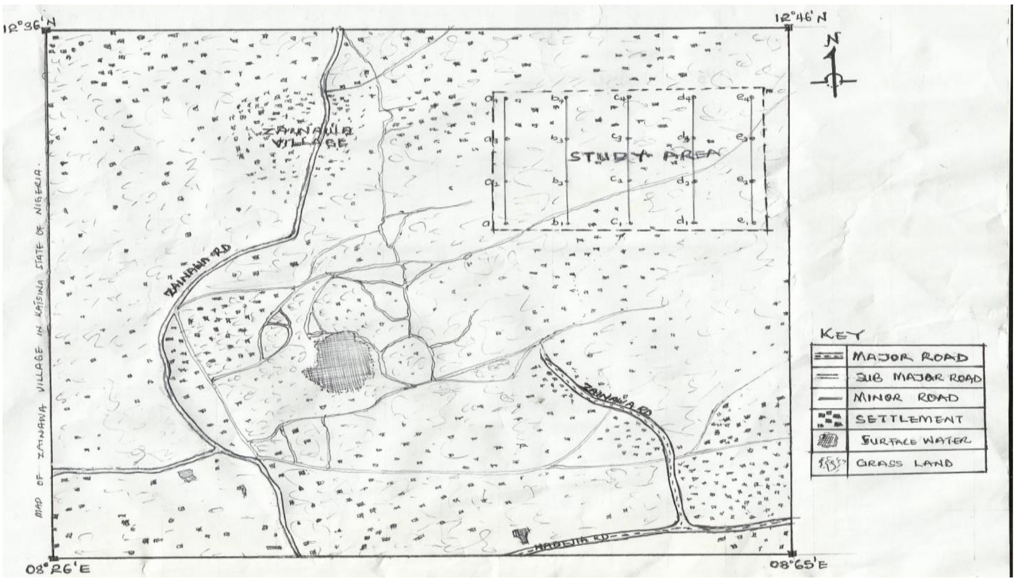
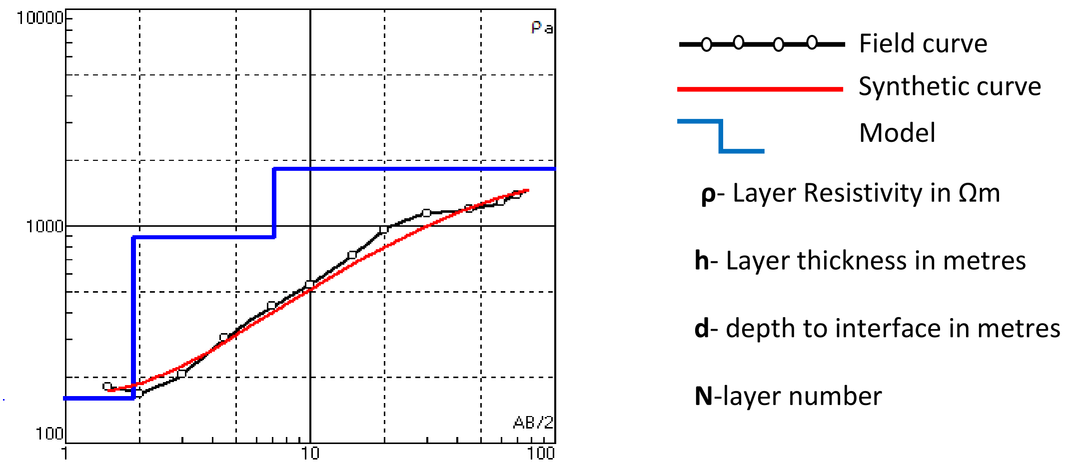


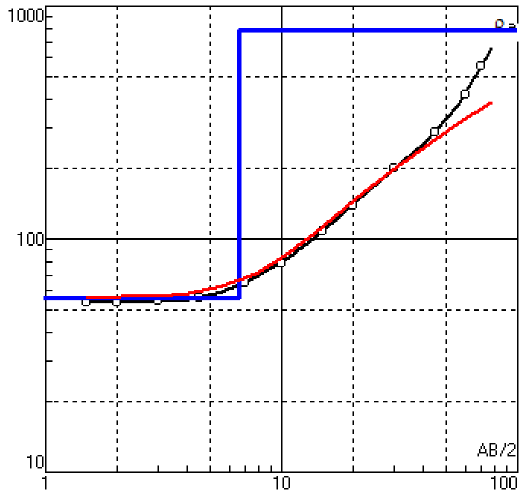
Figure 1: The location of the study area showing the five profile position A1-A6 to E1-E6 VES station in Zainawa village in Kano State.



Electrode spacing AB/2 (m)

N	ρ	h	d
1	161	1.89	1.89
2	888	5.21	7.11
3	1839		

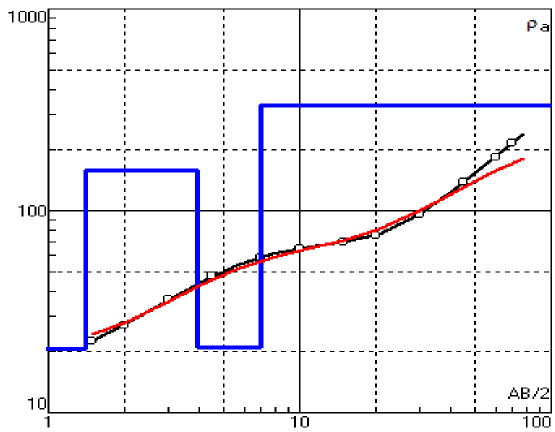
Figure2 (a) VES station A4



Electrode spacing AB/2 (m)

N	ρ	h	d
1	56	6.6	6.6
2	788		

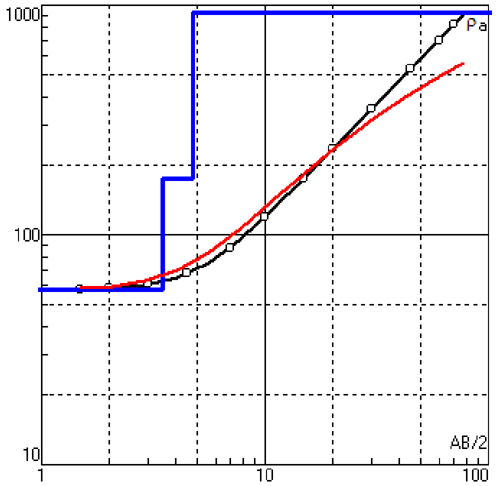
Figure 2(b) VES station B3



Electrode spacing AB/2 (m)

N	ρ	h	d
1	20	1.41	1.41
2	159	2.49	3.89
3	21	3.12	7.01
4	333		

Figure 2(c) VES station C4



Electrode spacing AB/2 (m)

N	ρ	h	d
1	57	3.48	3.48
2	175	1.28	4.76
3	928		

Figure 2(d) VES station E5

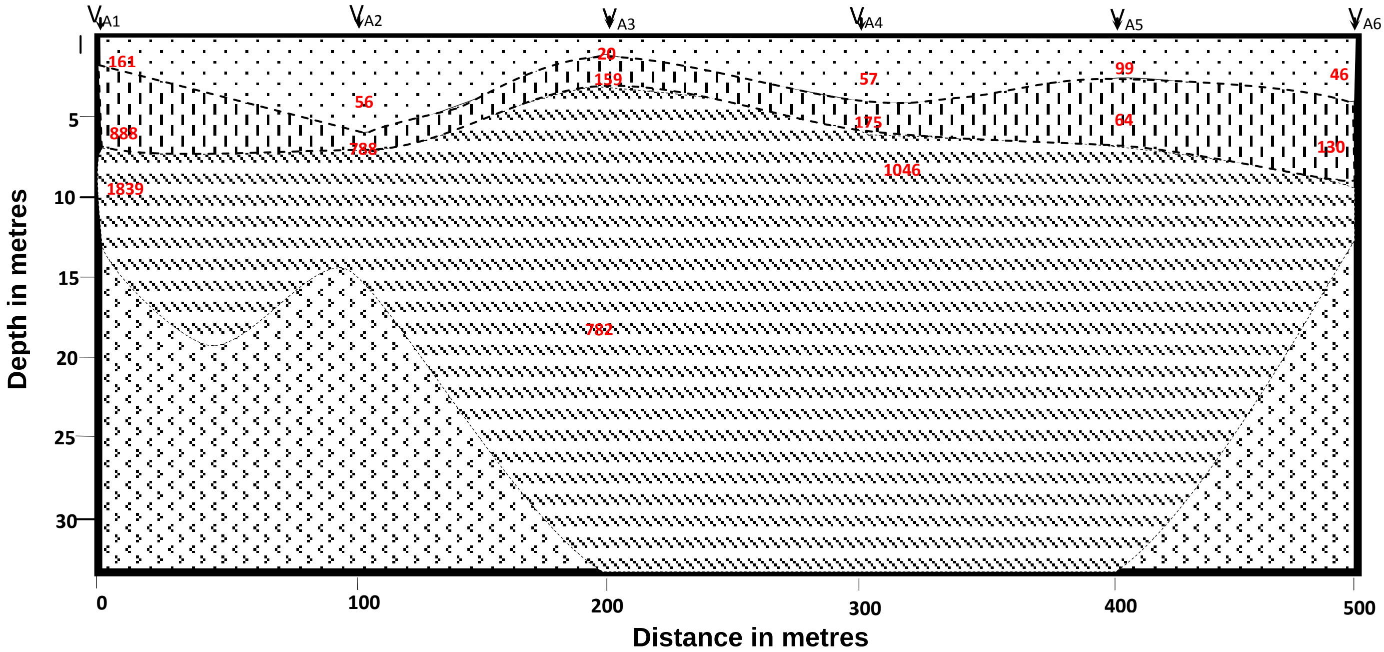


Figure 3 Geoelectric and geologic sections along profile A1-A6

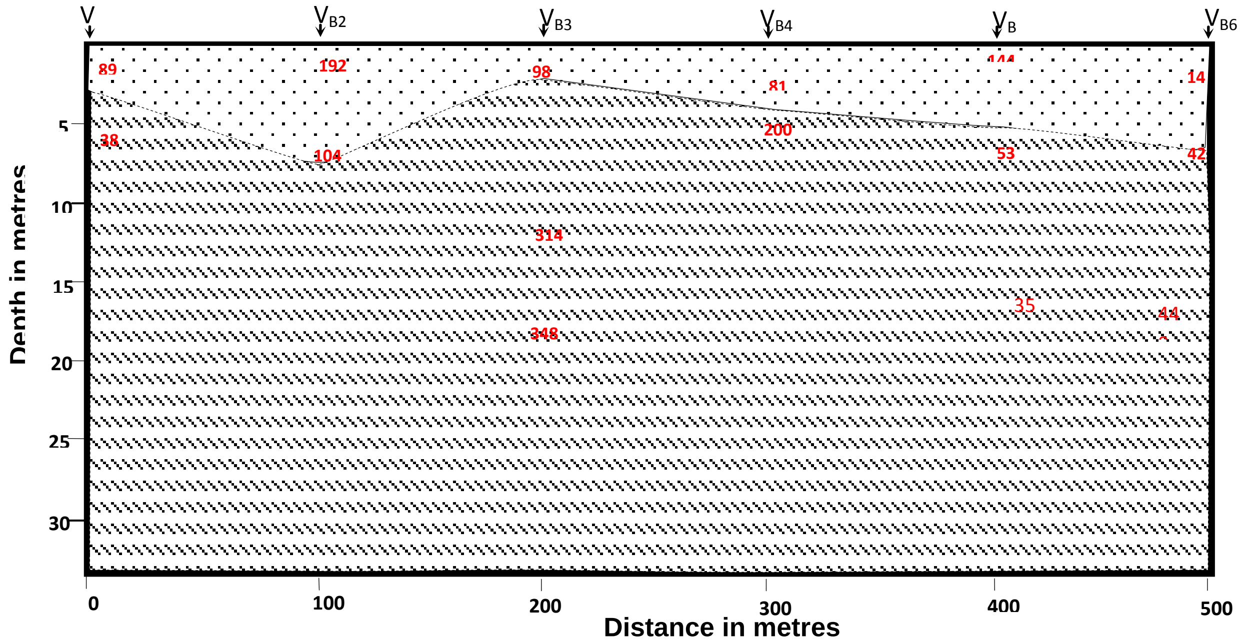


Figure 4 Geoelectric and Geology sections along profile B1-B6 and profile C1-C6

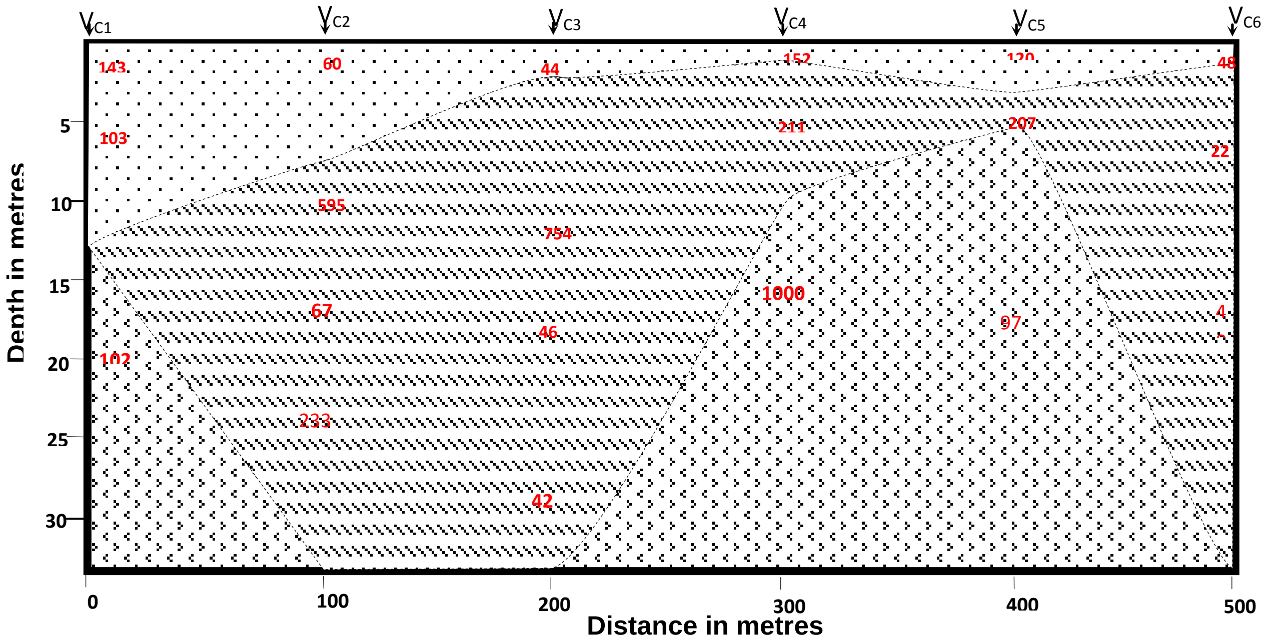
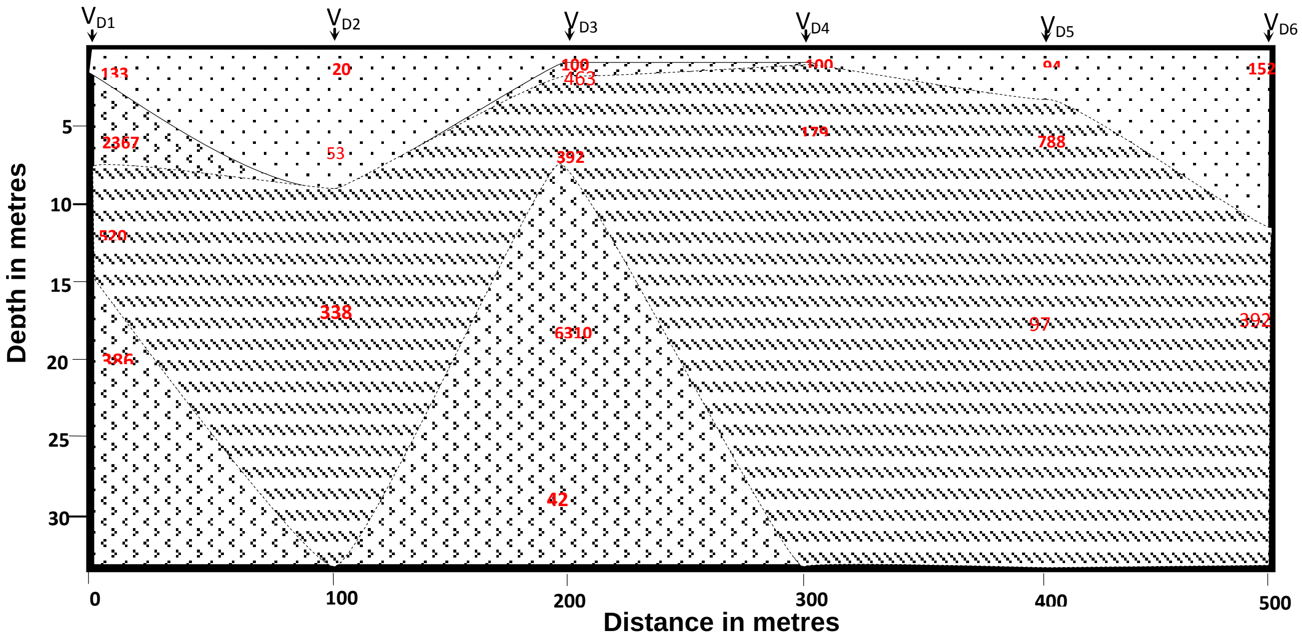
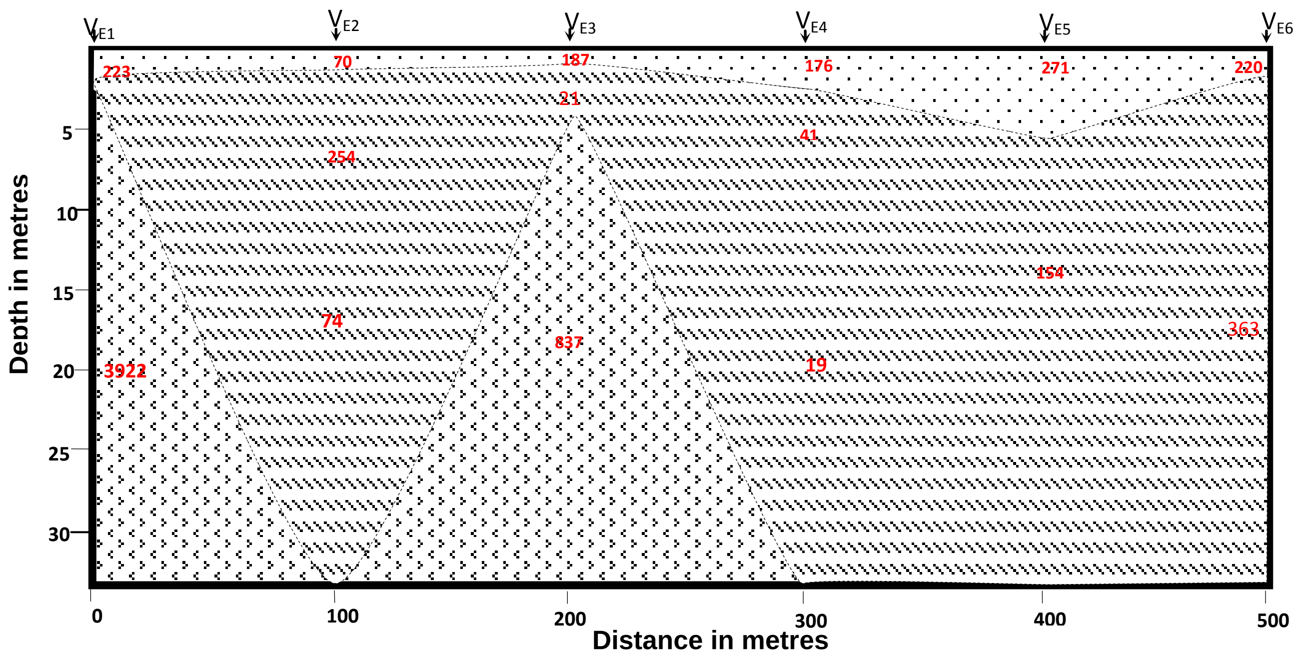


Figure 5 Geoelectric and Geologic sections along profile





LAYERS	RESISTIVITY VALUES (ΩM)	DESCRIPTION
Surface layer	22-168	Top soil, consist of saturated clay material.
Second layer	130-448	Weathered basement highly saturated with clay.
Third layer	200-800	Fractured /weathered basement considered as the water accumulation zone (aquiferous zone)
Fourth layer	>1000	Fresh basement, consist of gravel material.