Subsurface 2D Image Analyses of the Uyangha Basement Area, South-Eastern Nigeria

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Abstract: *Geo-electric soundings were made in Stella Maris Secondary School, in Uyangha, Nigeria to image the subsurface and obtain thicknesses and resistivities of different layers. A quantitative interpretation of the data obtained clearly reveals the presence of four (4) geo-electric sections which are interpreted to be dry laterite, moist laterite, weathered basement, and saturated basement. The depth probed is about 100m. The saturated basement is the aquifer unit. Depth to aquifer unit in the area is at about 65m to 80m.The thickness of the aquifer unit ranges from 20m to 35m. For ground water exploitation, boreholes in the area should therefore be drilled to the depth of 91m, for reasonable groundwater yield. The lateritic layer makes the study area suitable for building construction in the area.*
Keywords: *2-D imaging, electrical resistivity, vertical electrical sounding, pseudo-section, saturated basement.*

I.   Introduction

Geophysical surveys are aimed at detecting and locating subsurface geological structures and to measure their dimensions and their physical properties. Geophysical exploration methods are many, which can be classed according to the source of energy used in their measurement.

To select a suitable method to be used for any survey, a comprehensive knowledge of the geology of the area and site conditions are necessary. This is because in some instances, site conditions may preclude the successful use of most if not all geophysical techniques. The resistivity study requires the introduction of an artificial current into the ground through point electrodes or long line contacts. The potential in the earth (ground) due to the introduction of the current into the ground is measured using two potential electrodes which are planted on the ground surface. Since the current is measured as well, it is possible to determine the apparent resistivity of the subsurface. This however makes the resistivity method more superior (at least theoretically) to all the other electrical methods (Keary and Brooks 1991). It is important to note that, deviations from the pattern of potential differences expected from homogenous medium, provides information on the form and electrical properties of subsurface inhomogenities. The depth soundings or a vertical electrical sounding (VES) is also known as electrical drilling. It is the process by which depth investigations are made (Zohdy, et al., 1974).

The technique is best adopted to determining depth and resistivity for flat laying layered rock such as found in sedimentary terrains. The Schlumberger configuration is mostly commonly used for VES investigations.

The technique further finds application in geotechnical survey to determine overburden thickness and also in hydrogeology, to define depth and thickness of porous strata which are potential aquifers (Burger, 1992).

The objectives of the study are to attempt to identify the different rock types in the area and their vertical thickness using the electrical resistivity method.

This result will help to detect saturated layers for ground water exploitation in the area.

The apparent resistivity of the ground is a function of the measured impedance (ratio of potential to current) and the geometry of the electrode array (Burger, 1992).

II.   Geologic Setting

The study area is a basement terrain with an over burden. It is however a part of Oban Massif. The Oban Massif is located in the Southeastern region of Nigeria consisting of Precambrian basement complex, overlain by cretaceous to tertiary sediments of the Calabar flank. The Oban massif is in Southeastern Nigeria and includes mappable metamorphic rock units such as phyllites, schist, gneisses and amphibolites. The rocks are believed to have been intruded by pegmatites, granites, granodiorites. Outcrops of rocks in the area show that the rocks are intensively weathered which makes it difficult to obtain fresh rocks for geological identification (Ekwueme et al, 1995).

In Uyanga, the granodiorites enclose unmappable xenolith of meladiorite. This can be observed along the Calabar – Ikom road. The meladiorite is dark and fine – grained. The margin is basified; it is comprised dominantly of plagioclase, hornblende, minor quartz and biotite (Ekwueme et al, 1995).
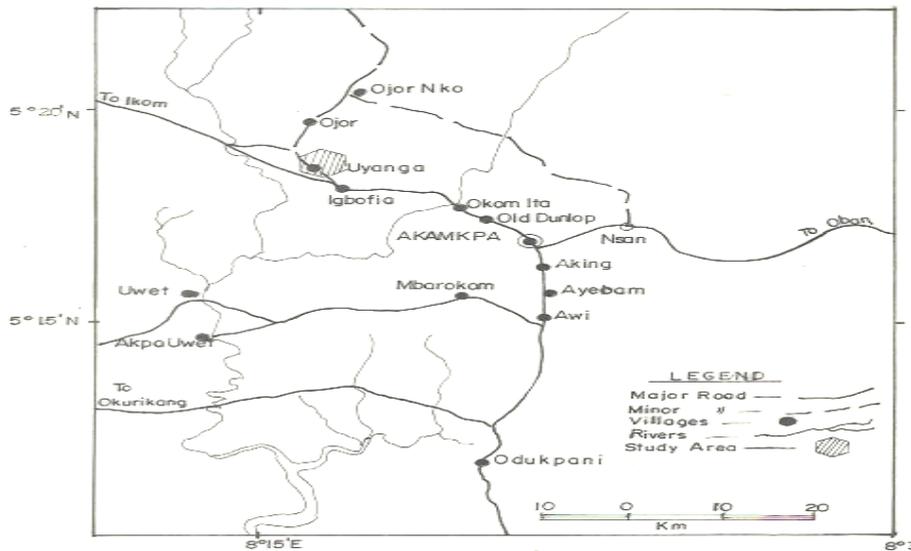
Figure 1: Location map of the study area.

The study area is located at the Stella Maris Seminary, Uyanga in the Akamkpa Local Government Area of Cross River State, Nigeria.

III.   Materials And Method

The instrument used to measure data is an ABEM TERRAMETER model SAS 300B.

A booster control unit is also incorporated in the terrameter to help drive large current into the ground in cases where a more resistive terrain is involved, other materials used are, the Global Positioning system, four electrodes, measuring tapes, hammers and cables. The electrode arrangement used in data acquisition is the Schlumberger array of electrodes.

IV.   Results

The observed field data was converted to apparent resistivity by multiplying with the Schlumberger geometric factor. The geometric factor for the Schlumberger array is given by:

$$G = \frac{\pi}{2l}(L^2 - l^2)$$

Where L= half current electrode spacing,
l = half potential electrode spacing

The apparent resistivity data were plotted against the half current electrode spacing in meters in the horizontal axis. The resistivity data were further interpreted using IPI2Win inversion software package (Bobachev, 2002).

The curves resulting from the plots are given below:

(a)
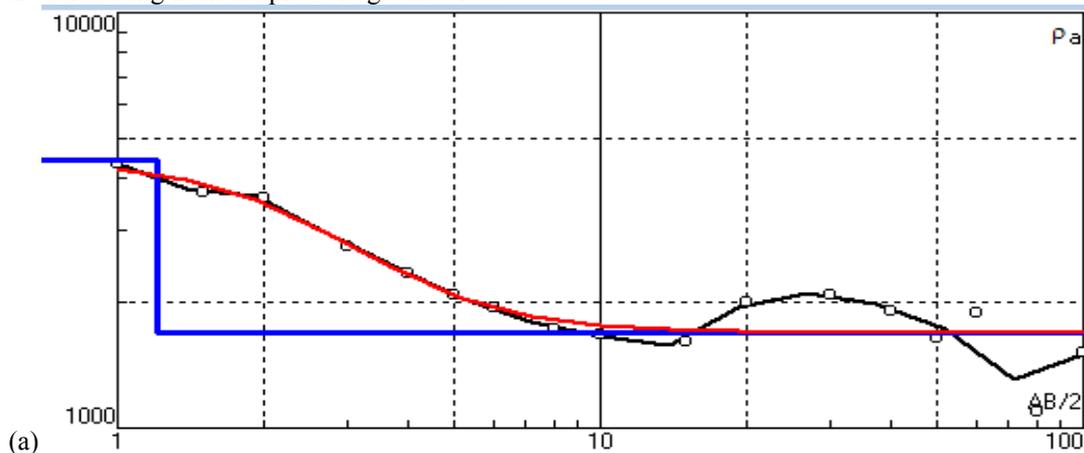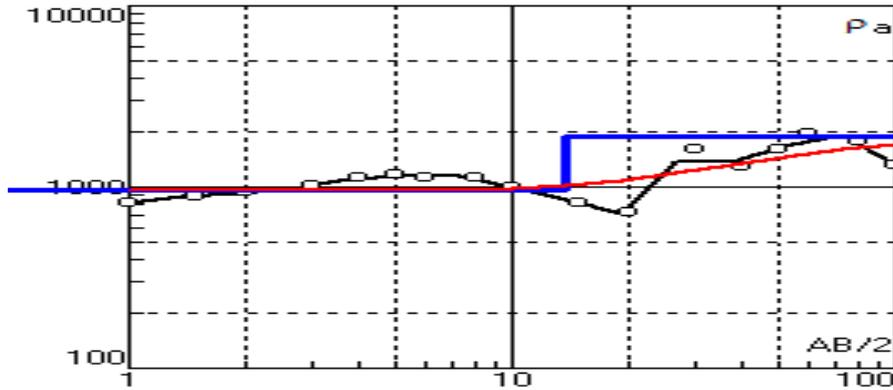
(b)

Figure 2: VES curves (a) and (b) representing plots for VES (1) and (2) respectively

The data obtained in VES 1 and VES 2 were analyzed using computer modeling technique. The output results obtained from the computer are shown above in Fig: 2a and Fig 2b.
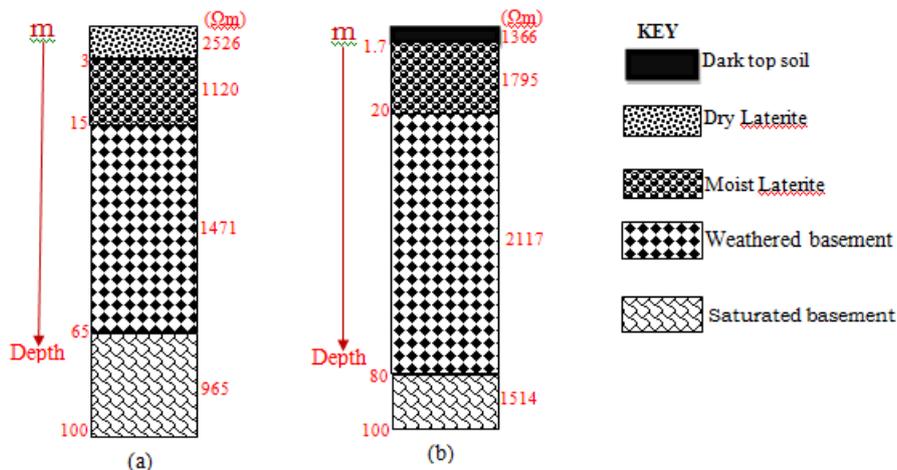

Figure 3: Geo-electric and inferred geologic sections for VES 1 and VES 2 respectively
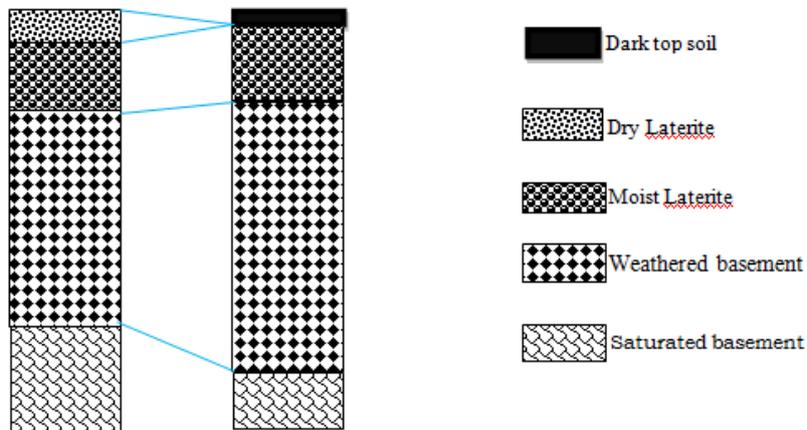

Figure 4: Correlation of inferredlithologic units of VES 1 and VES 2

It is observed from the above correlation that the dry lateritic layer evident in VES 1 did not appear in VES 2 which is covered with a relatively thin dark top soil layer. Thus in VES 1 the dark top soil has been washed by erosion over time. The weathered basement layer in VES 2 is thicker than that of VES 1. The results of parameters integrated from the geo-electric sections in the study area is presented in table 1 below. A pseudo-section, which is an attempt to present the appearance of the subsurface of the study area is given below in Fig.5

Table 1: Results of parameters integrated from the geo-electric sections in the study area

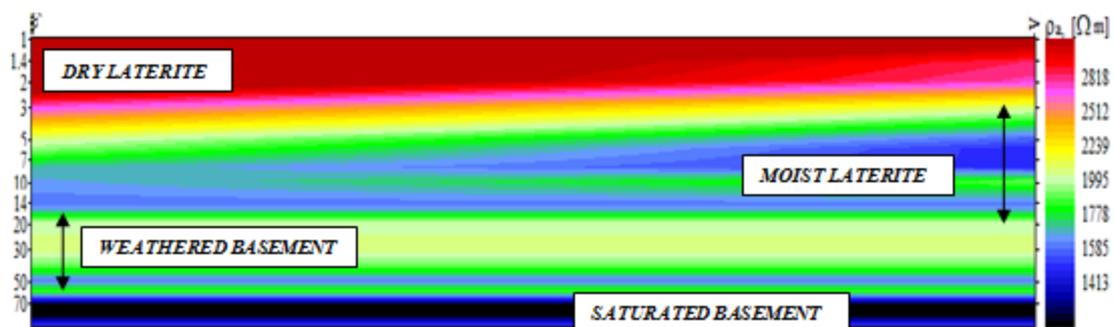| VES NO. 1	Layers	Depth (m)	Thickness(m)	Resistivity(Ωm)	Rock type
	1	3	3	2526	Dry Laterite
	2	15	12	1120	Moist Laterite
	3	65	50	1471	Weathered basement
	4	100	35	965	Saturated basement
VES NO. 2	1	1.7	1.7	1366	Top soil
	2	20	18.3	1795	Moist Laterite
	3	80	60	2117	Weathered basement
	4	100	20	1514	Saturated basement

Figure 5: A pseudo-section of the study area.

V. Conclusion

The result gives a 2D image of the subsurface, showing internal and vertical variations in resistivities. A quantitative interpretation of the data obtained clearly shows four layers in the geoelectric section which are interpreted to be dry laterite, moist laterite, weathered basement and saturated basement. Hence, the method adopted in the investigation of the study area has helped in the identification of aquifer unit. The groundwater can be exploited for the benefit of the Stella Maris students and residence of Uyangha, Akamkpa in Nigeria. Borehole in the area should be drilled to at least 91meters. The site is also suitable for classrooms construction.

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