Research Article

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Geophysical Study of Parts of Oru Area Imo State Nigeria Using Electrical Resistivity Method

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Abstract

Electrical resistivity method has been used in this research work to map the geological features in the Oru Area.Ten vertical electrical soundings were carried out within the study area. An Abem SAS 3000 terrameter and electrodes were used to acquire the resistivity data while a GPS system was used to obtain the co-ordinates of the survey points.

The resistivity data was processed using IP2win software while surfer II was used to produce contours of the resistivity data at various depths. Field mapping shows that the northern part of the study area rests on Ogwashi-Asaba formation. The area has mudstone, claystone gritty claystone, and carboniferous mudstone massive sandstone facies whereas Benin formation is found to the southwest from Mgbidi. Also found are clay deposits. There are both shallow and deep seated Aquifers in the Area.

Introduction

The aim of this research is to map the geological features within the study Area using Electrical resistivity method. Electrical resistivity method involves the application of current by conduction to the ground through electrodes. It depends on the fact that any subsurface variation in conductivity alters the form of the current flow within the earth and this affects the distribution of electric potential, the degree to which it is affected depending on the size, shape, location, and electrical resistivity of the subsurface layers or bodies. This means that we can obtain information about the subsurface from potential measurements made at the surface.

Information about the subsurface geophysical features obtainable within the Oru Area is not well established. In view of the growing population in this area it is needful to investigate and exploit the geological materials deposited in this area for the betterment of this populace.

Location and Geomorphology

The study Area is located in Imo State of Southeastern Nigeria. It lies approximately between Latitudes 5°37N and 5°82N and longitudes 6°50 E and 7°00E as shown in figure 1.0 which is the map of the study Area. Oru is bounded by the following towns from different directions Oguta, Nkwerre, Orlu and parts of Anambra State. The study area is made well accessible by quite a number of major, minor and track roads connecting the various villages and towns. The Location Map fig 1.0 is attached and shows a good number of communities within the Area.

The Study Area covers a landmass of about 315km^2 Southeast of Nigeria. It is within the Tropical Rain Forest which consists mainly of two major seasons, rainy season [March to October] and the dry season [November to February]. The harmattan occurs within the dry season. The Oru Area has a daily temperature range of 31°C to 33C during the dry season and a range of 24°C to 26°C during the rainy season.

Most part of the Study Area is level land. It has the tropical Rain forest type of vegetation. The vegetation is made up of economic crops of different species like palm trees, grasses of all types and food crops.

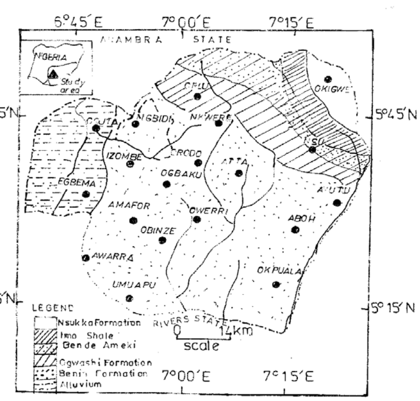

Figure 1: Location map of Oru Area from Imo State Ministry of Lands and Survey

Geology and Hydrogeology of the Study Area

The Oru Area is made up of two geological formations, the Ogwashi–Asaba and the Benin formation which was formerly known as Coastal Plain Sands [1]. Ogwashi – Asaba formation is characterized by alternation of clays and sands and grits and lignites [2,3]. The formation occurs mainly in Asaba, Benin, Onitsha and Owerri Areas. Reyment suggested Oligocene – Miocene age for this formation. For the Benin formation, the sands and sandstones are coarse to fine grained and commonly of granular texture. The formation consists of friable sand with intercalations of shale and clay lenses occurring occasionally at some depths [4]. The formation is partly estuarine, partly lagoon, partly deltaic and fluvid lacustrine in Origin [1]. The sands and sandstone in this formation are coarse grained, very granular, pebbly to very fine grained. They are either white in colour or yellowish brown. Hematite grains, feldspars are also obtained. The shale are greyish, brown, sandy to silty and contains some plant remains and dispersed lignites [4]. The formation has an average thickness of 600ft (196.85m) [5]. Benin formation is continental in origin and accurately represents the delta plain facies.

Surface waters are not a major feature of the Oru area. The Njaba and Obana rivers are the only surface waters in the area. The two formations are known to have reliable groundwater that could sustain borehole production. The high permeability of the Coastal Plain Sands, the overlying lateritic earth and the weathered top of this formation provide the hydrolic conditions favouring aquifer formation in the study Area. The copious rainfall that prevails in the area makes the aquifer prolific and continuously provides the groundwater recharge. It is indeed an excellent source of groundwater. The fig 2 below shows the geological map of the study area

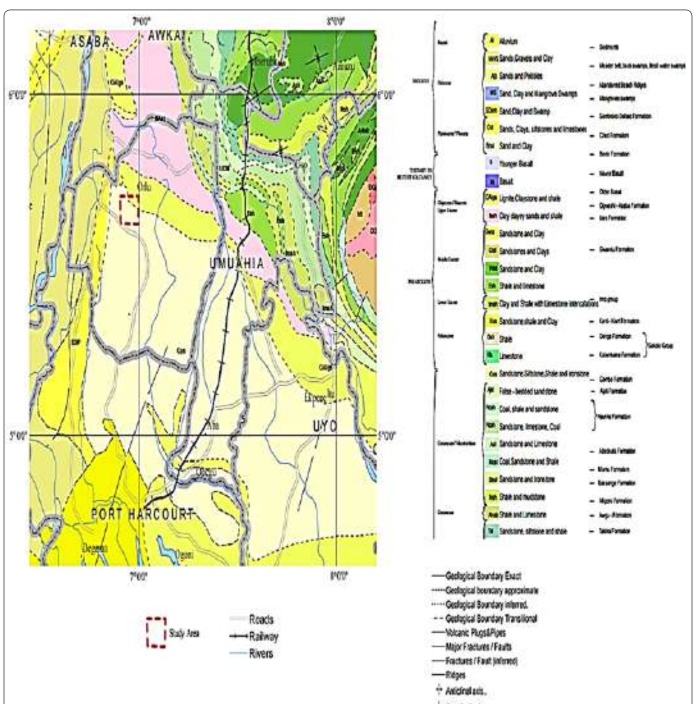

Figure 2: Geological map of Nigeria showing the study Area from Nigerian Geological Survey, Abuja

Materials and Methods

The basic instruments that were used for this survey includes: Abem terrameter SAS 3000, Global position system (GPS) for measuring co-ordinates and altitude, two potential electrodes, two current electrodes four electrical cable reams, measuring tape, geological hammers and recording papers/sheets.

A total of ten vertical electrical soundings were acquired at different locations in the study Area using the Abem Terrameter SAS 3000. The electrode array used was the schlumberger arrangement. The observed field data were converted to apparent resistivity values by multiplying with schlumberger geometric factor. The geometric factor for the schlumberger array is given by the relationship

$$G = n\left(\frac{a2}{B} - \frac{b}{4}\right)$$

Where a = half current electrode spacing

B = potential electrode spacing

The apparent resistivity values were plotted against half electrode spacing on logarithmic co-ordinates to obtain the sounding curves from which resistivity and thickness of the layers were determined. The 1p2 win software was used to obtain the contouring of resistivity at various depths at the surface 0m, 10m, 20m, 30m, 40m, 50m, and 60m so as to study the occurrence of geological materials at these depths.

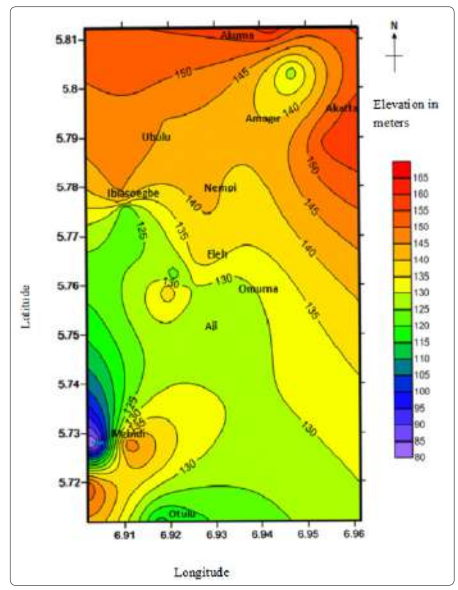

Figure 3: Elevation model of the study area

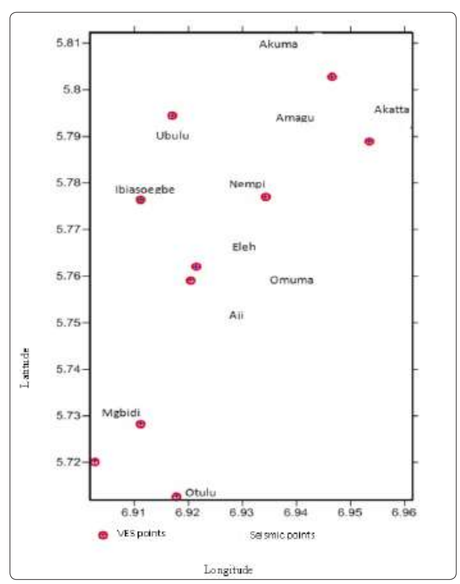

Figure 4: Location of ves points in the area

Results and Discussions

The survey results shall be presented and discussed using the following figures. Figure 3 represents the elevation model of the study area figure 4 shows the location of VES points in the area figures 5-14 are the resistivity curves for the ten VES carried out in the area of study. The resistivity distribution within the study area at various depths at the surface at 10m depth, at 20m depth, at 30m, 40m, 50m and at 60m depth are presented in figures 15-21.

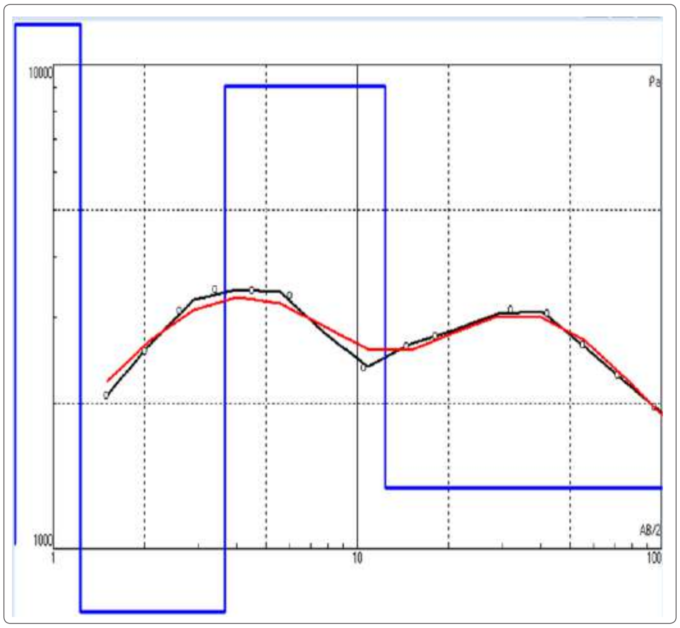

Figure 5: Resistivity curve at Akuma

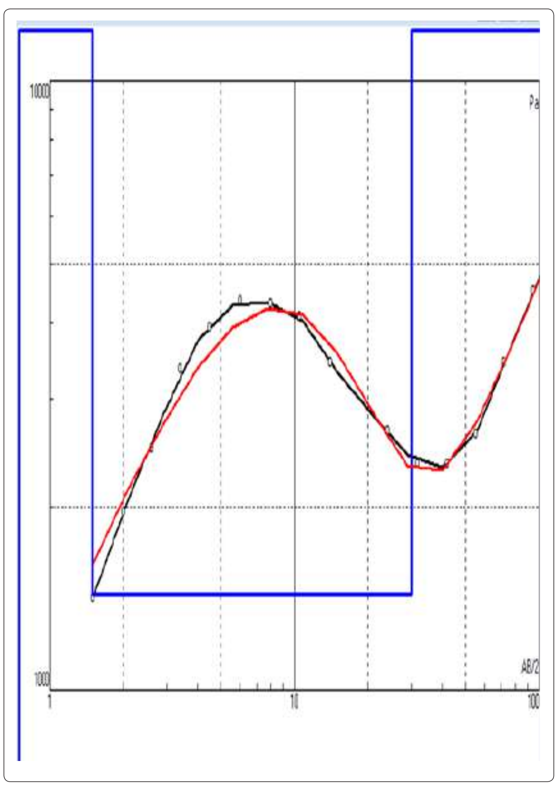

Figure 6: Resistivity curve at Ubulu

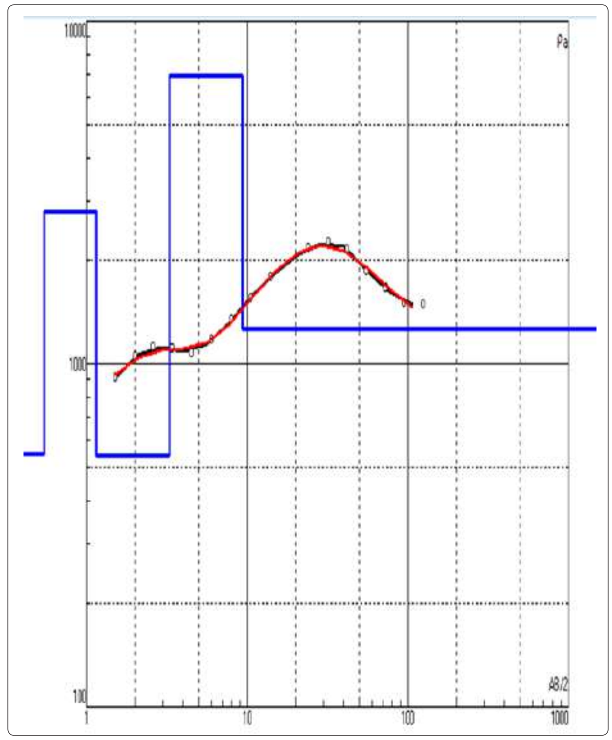

Figure 7: Resistivity curve at Aji

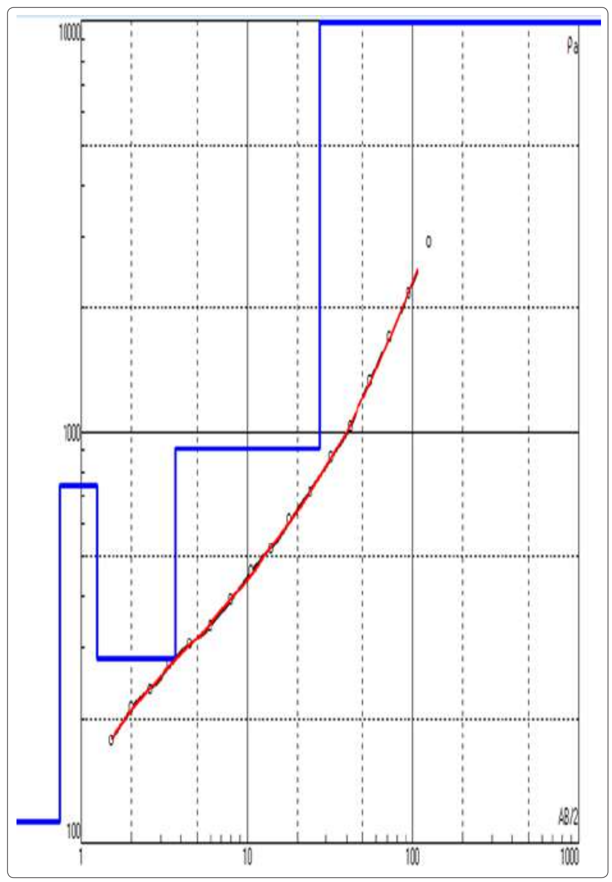

Figure 8: Resistivity curve at Akatta

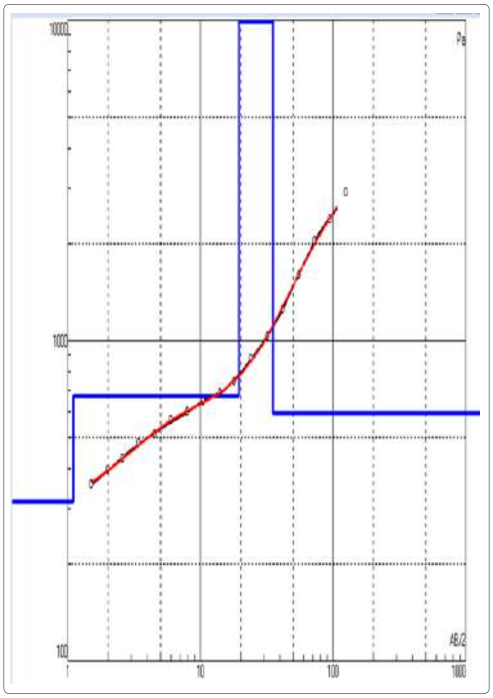

Figure 9: resistivity curve at Nempi

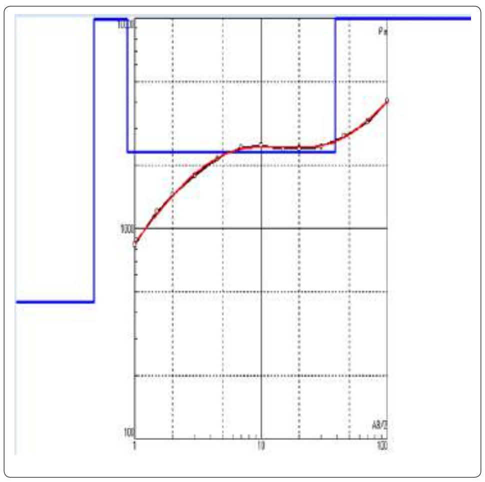

Figure 10: resistivity curve at Ibiasoegbe

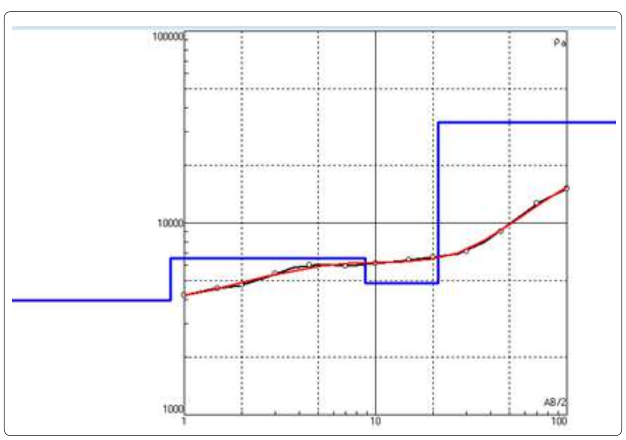

Figure 11: Resistivity curve at Mgbidi2

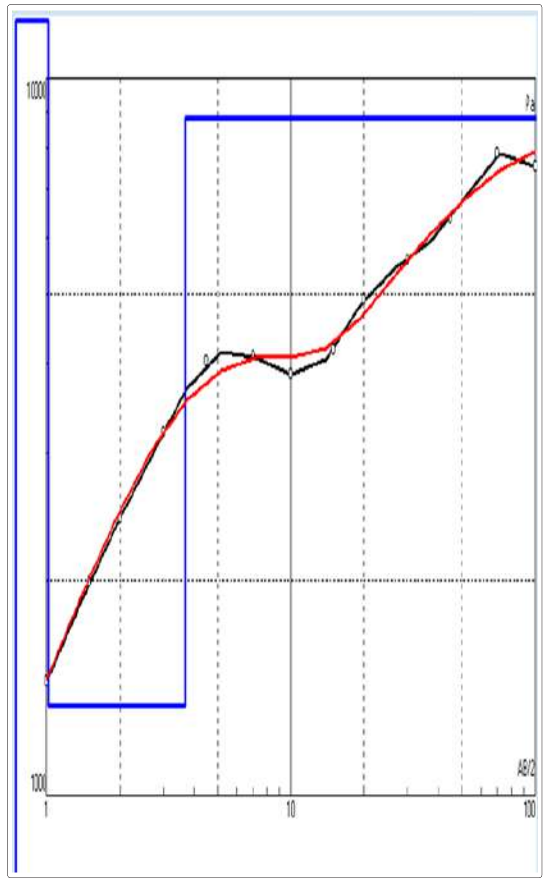

Figure12: Resistivity curve at Mgbidi 1

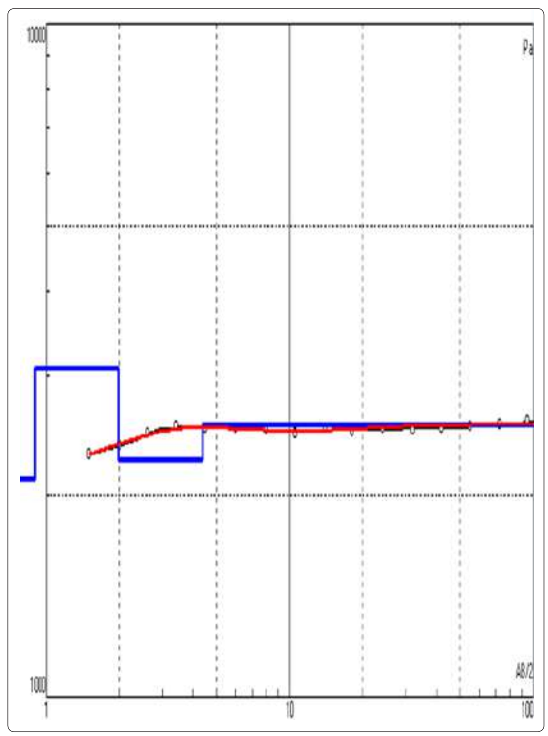

Figure 13: Resistivity curve at Umuoji

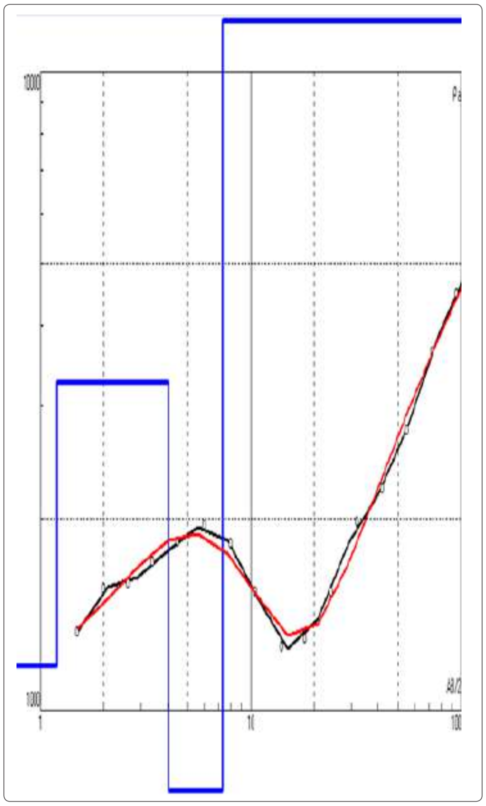

Figure 14: Resistivity curve at Otulu

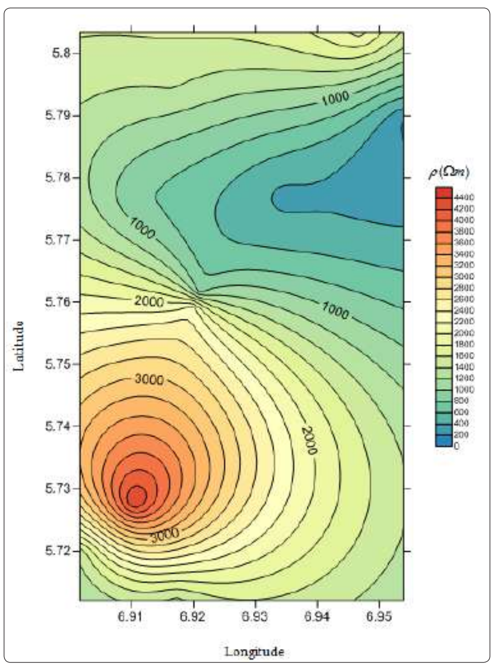

Figure 15: Resistivity at the surface of the study Area

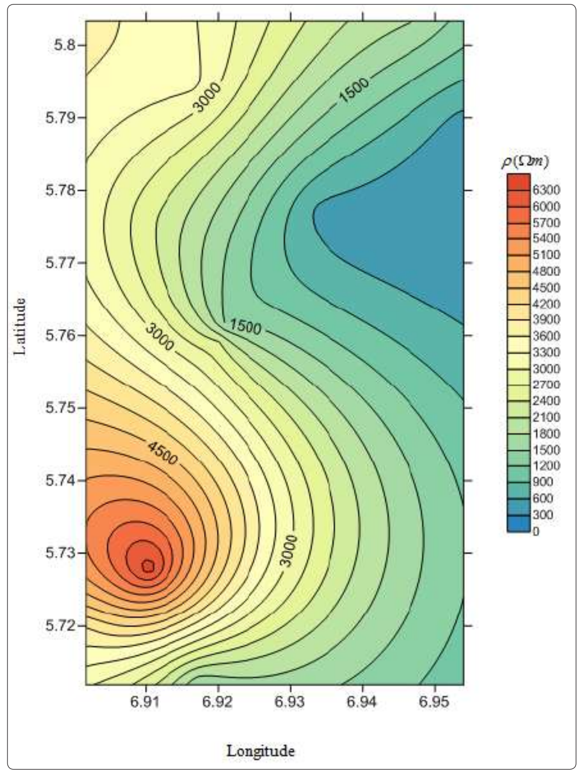

Figure 16: Resistivity distribution at 10m depth

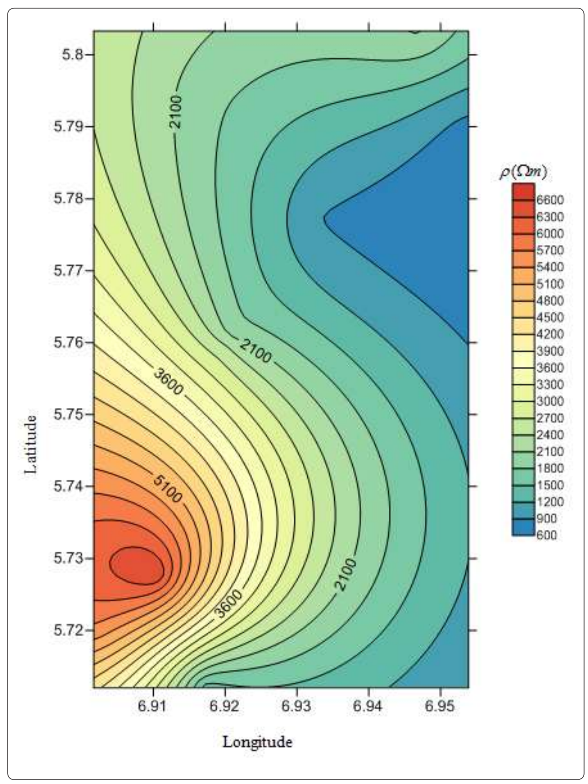

Figure 17: Resistivity distribution at 20m depth

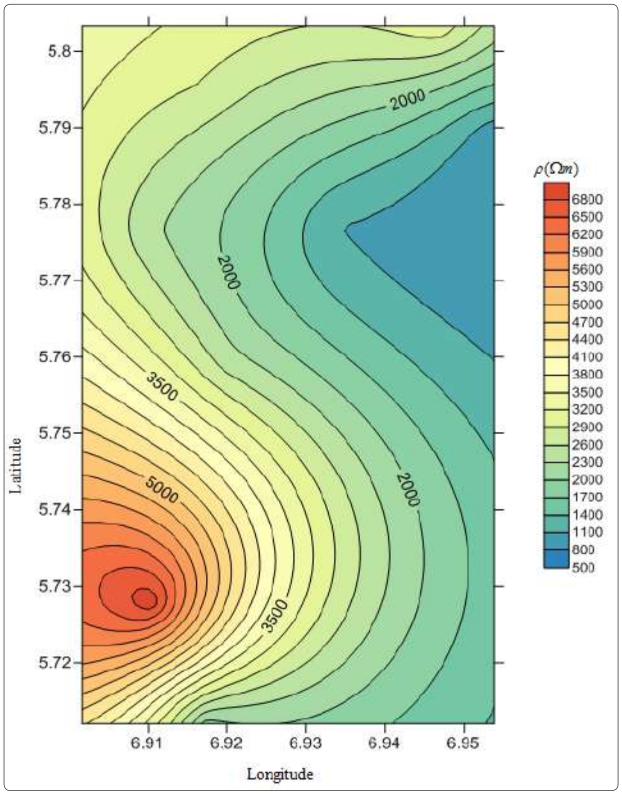

Figure 18: resistivity distribution at 30m depth

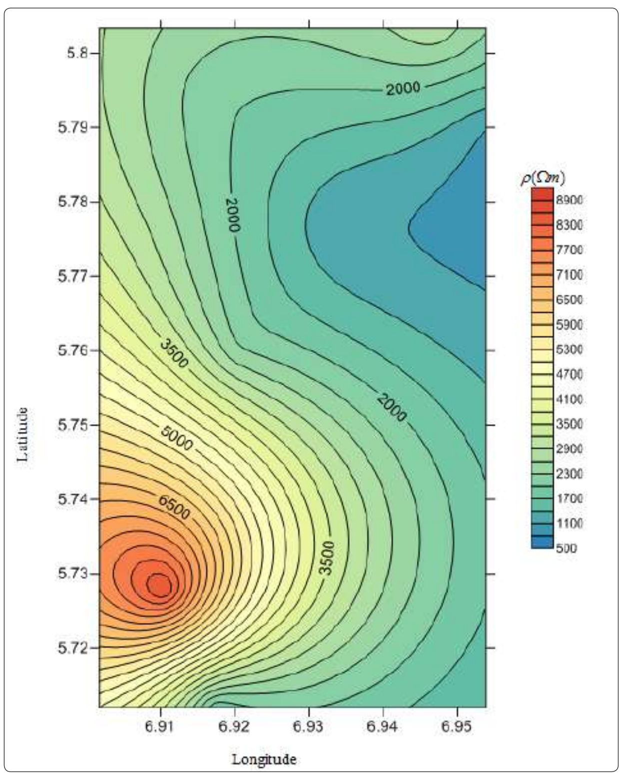

Figure 19: Resistivity distribution at 40m depth

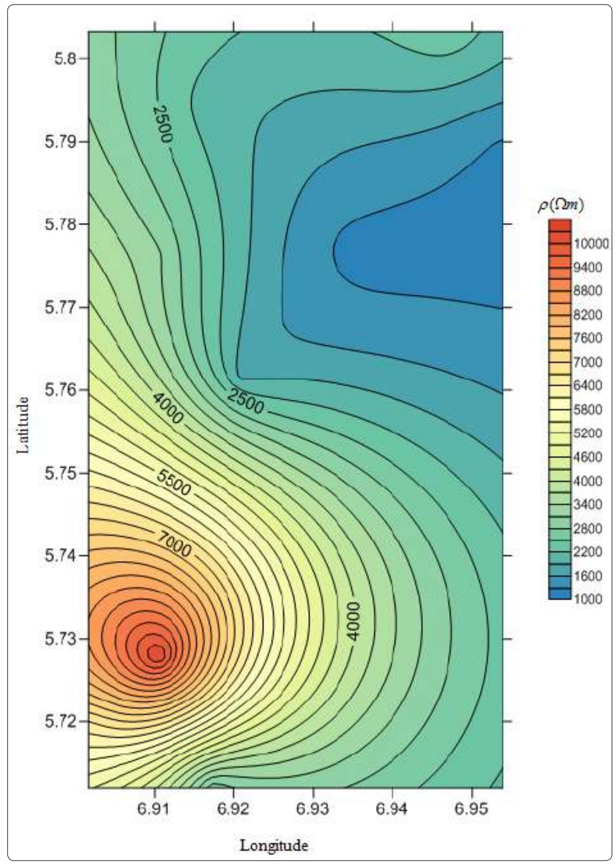

Figure 20: Resistivity distribution at 50m depth

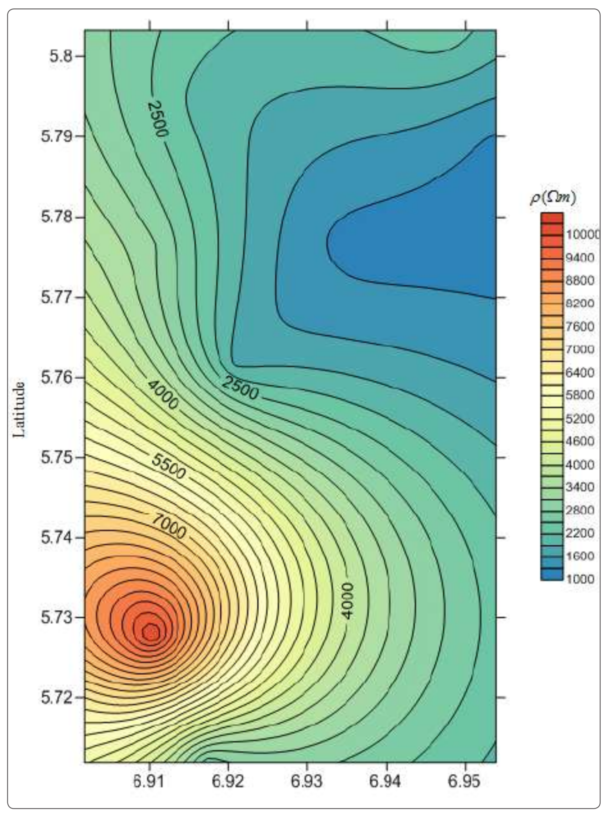

Figure 21: Resistivity distribution at 60m depth

Depositional processes at the study area critically influence signatures of the conducted resistivity survey as shown in figures 5-14 and figures 15-21. Characteristics of Ogwashi-Asaba formation which rested at the North of the study area and includes Akuma, Amagu, Akatta, Ubulu and some parts of Nempi was clearly delineated by the elevation map figure 3. This coastal floodplain materials (Ogwashi Asaba), deposited in Miocene age lies in the NW-SE direction beneath the recent aged Benin formation characterized by the southwest of the study area. Some of the features noted from the results include the evolution of the sediments in the study area, clay zones, voids depths to acquiferou's layers. Resistivity curves and distribution at various depths fig 5-14 and fig 15-21 suggest two main geological domains in the area; Area of high resistivity and area of low resistivity reflecting the nature of the domains. The nature of the geological materials in these domains is responsible for this situation. Also noted is a lateral variation in geological materials due to lateral variation in resistivity across the study area. Resistivity value is less than 300 ohm meter at Akatta topsoil as in fig 8 and fig. 15. The village maintained low resistivity even at an increased depth. Akatta village showed a resistivity value of about 1000 ohm meter at 60m below as in fig 8 and fig 21.

Water saturated layers, section of clay materials and depositional pattern can be traced using the resistivity profile plots fig 5-14 and resistivity distribution plot fig 15-21 respectively.

Evolution of the sediments in the study area

A tidally influenced coastal plain depositional environment saw to the deposition of sediments within the Northern part of the study area which may be described as mudstone, carboniferous mudstone, claystone, gritty claystone and massive sandstone facies [6]. These materials are suggested to be deposited during the late phase of Miocene-Oligocene after which the Benin formation deposition covering the south end of Oru through Ibiasoegbe and parts of Nempi broke in during Pleistocene. Signatures from the resistivity distribution maps are predominantly in N-S predominant orientation.

Possible depth of Aquifer

VES results fig 5-14 and 15-21 suggest that both shallow and deep seated aquifers are in the study area. A very close observation of the resistivity curves of the VES points in the study Area suggest that the water table can be accessed at the following depths

Table 1: Possible Depths of Aquifer

VES POINTS	Direction of VES	Depths
Akuma	SW-NE	10m AND at 100m
Ubulu	SW-NE	20m
Aji	NE-SW	5m and at 100m
Akatta	SE-NW	30m
Nempi	NE-SW	30m
Ibiasaegbe	SE-NW	30m
Mgbidi	NW-SE	20m
Mgbidi 1	NE-SW	10m
Umuoji	NW-SE	5m
Otulu	NE-SW	8m

Clay zones

In the area of study the likely depths to clay deposit are as follows

Table 2: Depths To Clay Zone

VES points	Direction of VES	Range of depth
Akuma	SW-NE	Nil
Ubulu	SW-NE	Nil
Aji	NE-SW	2m
Akatta	SE-NW	2-40m
Nempi	NE-SW	2-30m
Ibiasoegbe	SE-NW	Nil
Mgbidi 2	Nw-SE	2-40m
Mgbidi 1	NE-SW	Nil
Umuoji	NW-SE	Nil
Otulu	NE-SW	nil

Table 3: Borehole Data of Ura-Akatta in the Study Area

Depth (m)	lithology
0.0-6.9	Sandy topsoil
6.9 – 14.7	shaly sandstone
14.7 – 33.8	Clay mudstone
33.8 – 46.0	Silt sand
46.0 – 60.3	Sand
60.3 – 120.0	Sand stone shale prospective unit

Table 4: Borehole Data of Akwada-Aji in the Study Area

Depth(m)	lithology
0.0-8.1	sandly topsoil
8.1-17.5	clay silty sand
17.5-39.9	sandstone and shale
59.9-50.5	Sandstone
50.5 – 65.5	Sand/gravel
65.5- 92.2	Prospective Aquifer sand

Table 5: Comparison of depths to clay deposits and aquiferous zones by ves and borehole data

Town	Range of depth to aquifer zone by VES curves (m)	Depth to aquifer zone by borehole data (m)	Depth to Clay zone by VES curves (m)	Depth to clay zone by Borehole data (m)
Akuma	At 10m and at 100m		Nil	
Ubulu	20m		Nil	
Aji	At 5m and at 100m	39-92	2	8-17.5
Akatta	30m	30-120m	2-40	14-39
Nempi	30m		2-30	
Ibiasoegbe	30m		Nil	
Mgbidi 2	20m		2-40	
Mgbidi 1	10m		Nil	
Umuoji	5m		Nil	
Otulu	8m		Nil	

A careful study of the table above reveals that there is a fair agreement in the range of depths to clay deposits and aquiferous zones predicted by VES data and borehole data [7].

Conclusion

Field mapping shows that the northern part of the study area rests on Ogwashi Asaba formation. The area has mudstone claystone, gritty claystone, carboniferous mudstone, massive sandstone facies whereas Benin formation is found to the southwest from Mgbidi. The area has deposits of clay as well as shallow and deep seated acquifers [8-10].

Recommendations

Looking at the results of this work, it is recommended that there should be further study of the clay deposits in this area and see if it can be exploited for industrial purposes and hence enhance the economy of the area.

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