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Full Length Research Paper

Geoelectrical investigation of geologically controlled hydro-geophysical parameters in Item area, of South Eastern Nigeria

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Predominantly argillaceous rock units of middle to upper cretaceous age underlie Item area of South Eastern Nigeria ranging locally from Nkporo Formation (Mid Createaceous) to Ajali (Upper Maastrichtian). While the older Central and Northern sections of the area are underlain by shales and limestones, the Southern area is younger and consists of quartz arenitic sands. Vertical Electrical Sounding data from nine locations indicate overriding shaly conditions from 3 m in all the Central and Northern areas while only one location in the south shows predominant sandy geoelectric section. Results from Vertical Electrical Soundings show that only the sandy location has resistivity of over 350 Ohm-m at depths of 100 to 150 m. It is thus concluded that only one location has positive potentials for underground water. Rather than embark on any drilling in the remaining eight locations, the perennial surface water sources could be exploited to give treated water to item community.

Key words: Geoelectrical, createaceous, sediments, overiding shales.

INTRODUCTION

Item clan is located between latitudes 5°40' and 5°50' N and longitudes 7°38' and 7°45' E (Figure 1). Heights above sea level range from 47 to 115 m. In the years between 1983 and 1985, various studies involving mainly surface geological investigations were carried by Imo State government of Nigeria in the area to determine the possibility of sub-surface water occurrences. Because of overriding shaly units that outcrop in most of the villages, a surfaces water treatment plant (BEWAC) was installed at one of the streams (Akwa River, Figure 1). Attempts to drill positive wells for water supply have failed in eight of the nine villages. Thus this brings about the need to use a geophysical method to establish the true sub-surface water situation. Some times people need to trek for 5 km for surface water, thus motivating the present study.

MATERIALS AND METHODS

Two principal methods were employed in the present study as follows:

Geological studies

Mapping was carried out on a scale of 1: 100,000 to delineate the various rock types and their trends. This gave the map shown in Figure 1.

Geophysical method

The electrical method using the Schlumberger array where half current electrode spacing ranged from 1.5 to 500 m was employed. Potential electrode spacing ranged from 1 to 110 m. The ABEM Terrameter model SAS 1000 was used in the field reading operations. The field data was reduced through the Schlumberger equation given by:

$$\rho_a = \pi\left(\frac{a^2}{b} - \frac{b}{4}\right)R$$

Where ρ_a = apparent resistively in Ohm-m, a = AB/2 = half current electrode spacing in metres, b = MN = potential electrode separation in metres R = meter reading in Ohms. The reduced data was plotted on log-log graphs to yield field curves of ρ_a values against AB/2 values. Field curves were observed for layers and curve types. Preliminary apparent resistivity and depth data from

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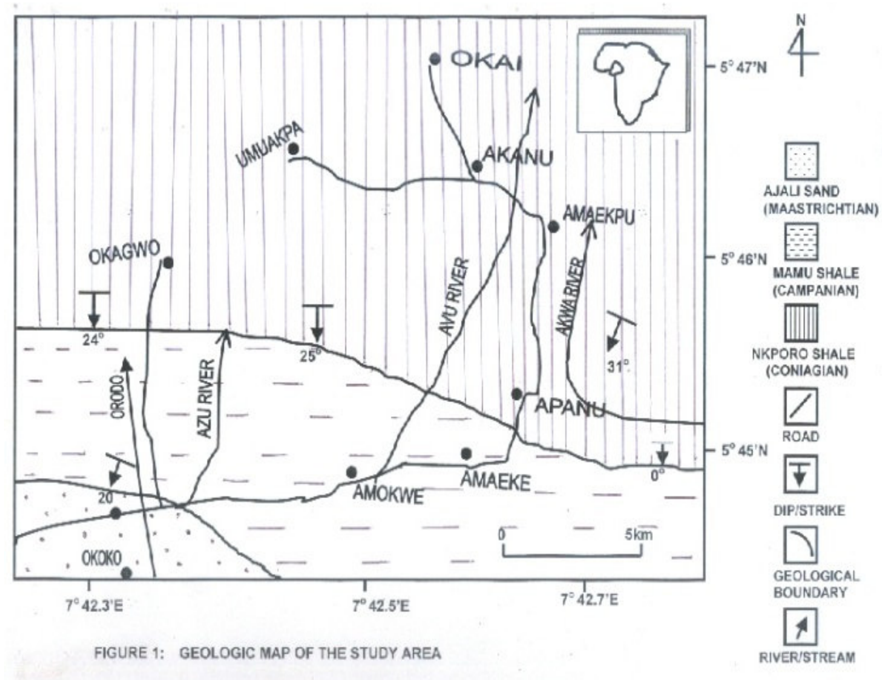
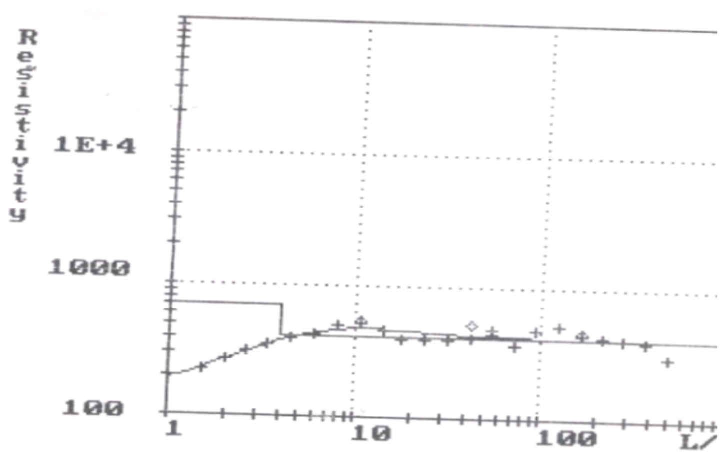


Figure 1. Geologic map of the study area.



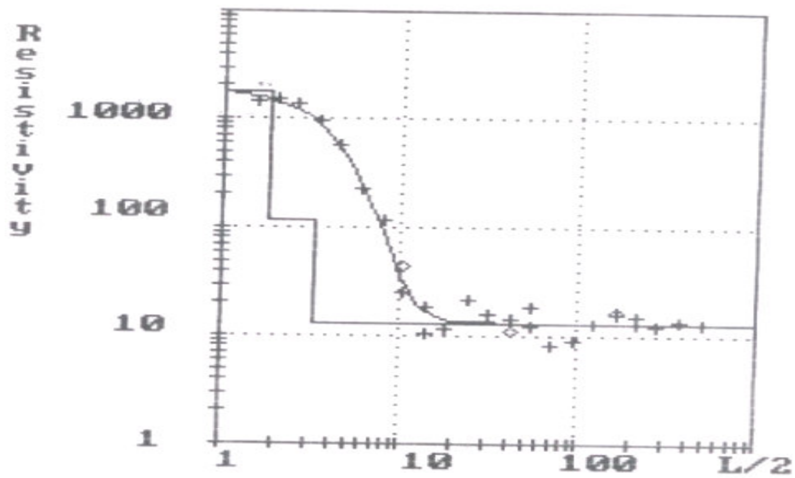
Resistivity (Ohm m)	Depth (m)
167.0	0.9
699.0	3.9
419.0	

Figure 2. Interpreted electrical resistivity curve at Okoko.

the field curves were fed into a Zohdy software to yield true resistivities and boundaries to geoelectric layers as shown in Figures 2, 3, 4, 5 and 6.

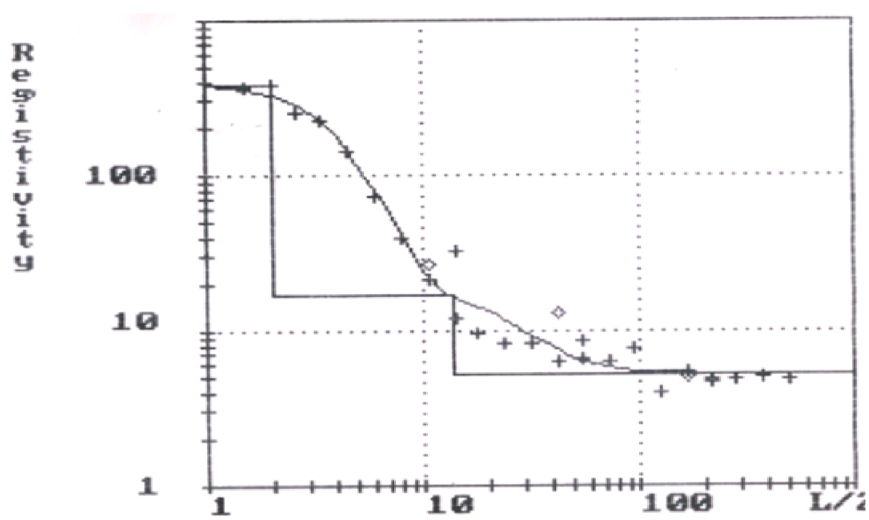
RESULTS AND DISCUSSION

The geological map as shown in Figure 1 shows that the formations within the area of study trend nearly East-west and dip towards the south. Dip values range from 20 to 35° to the south and South-west. The Southern portion of the area is a part of the east-west trending ridge. This ridge is a continuation of the famous Enugu escarpment in Eastern Nigeria. While heights above sea level in the south are up to 600 feet, those for the Northern part are less than 300 feet. Thus stream flows are topographically controlled. The sounding areas to the south are the water



Resistivity (Ohm m)	Depth (m)
1780.0	1.8
119.0	3.3
12.7	

Figure 3. Interpreted electrical resistivity curve at Apanu**.**

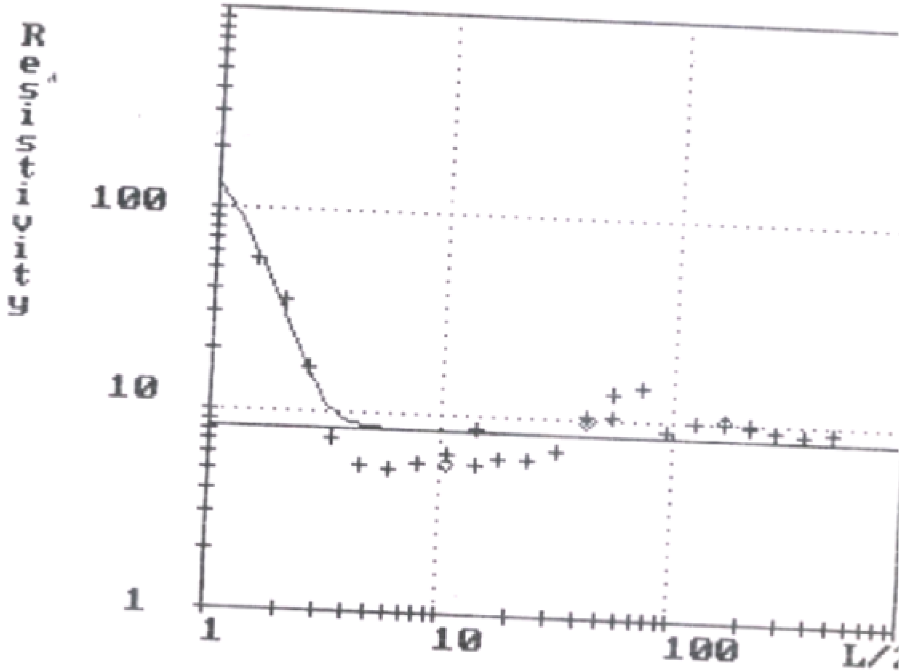


Resistivity (Ohm m)	Depth (m)
389.0	2.0
17.0	13.5
10.0	

Figure 4. Interpreted electrical resistivity curve at Akanu.

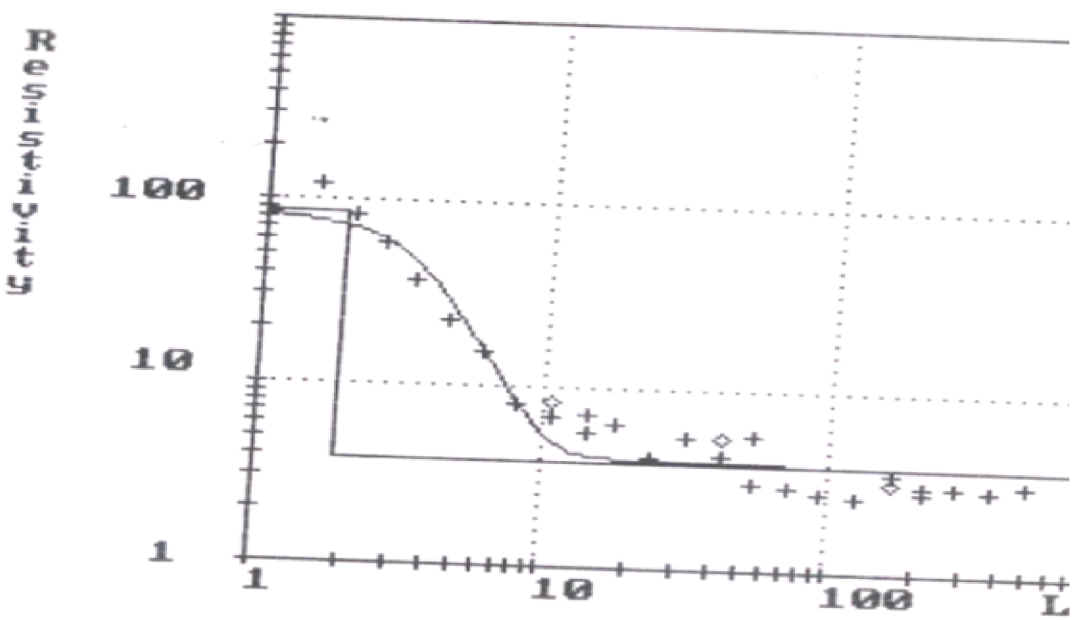
intake points, releasing such down topographic dip rather than geological dip. Apart from locations where overriding sandy units were observed in road cuts, the rest of the nine locations are either completely shaly or have limestone bands/boulders as observed in Umuakpa, Figure 1. The geoelectric fence diagram is shown in Figure 7 while the interpreted resistivity curves are shown in Figures 2, 3, 4, 5 and 6.

Furthermore equi-resistivity contour maps, Knasewick, (1975), Keller and Frischknecht, (1977), for AB/2 at 2, 4.5, 7.5, 15, 24, 50, 75, 100, 150, 250, 300 and 500 m are shown in Figure 8. Results shown in the geoelectric



Resistivity (Ohm m)	Depth (m)
235.0	0.6
8.1	

Figure 5. Interpreted electrical resistivity curve at Okai.



Resistivity (Ohm m)	Depth (m)
85.0	1.9
3.9	

Figure 6. Interpreted electrical resistivity curve at Umuakpa.

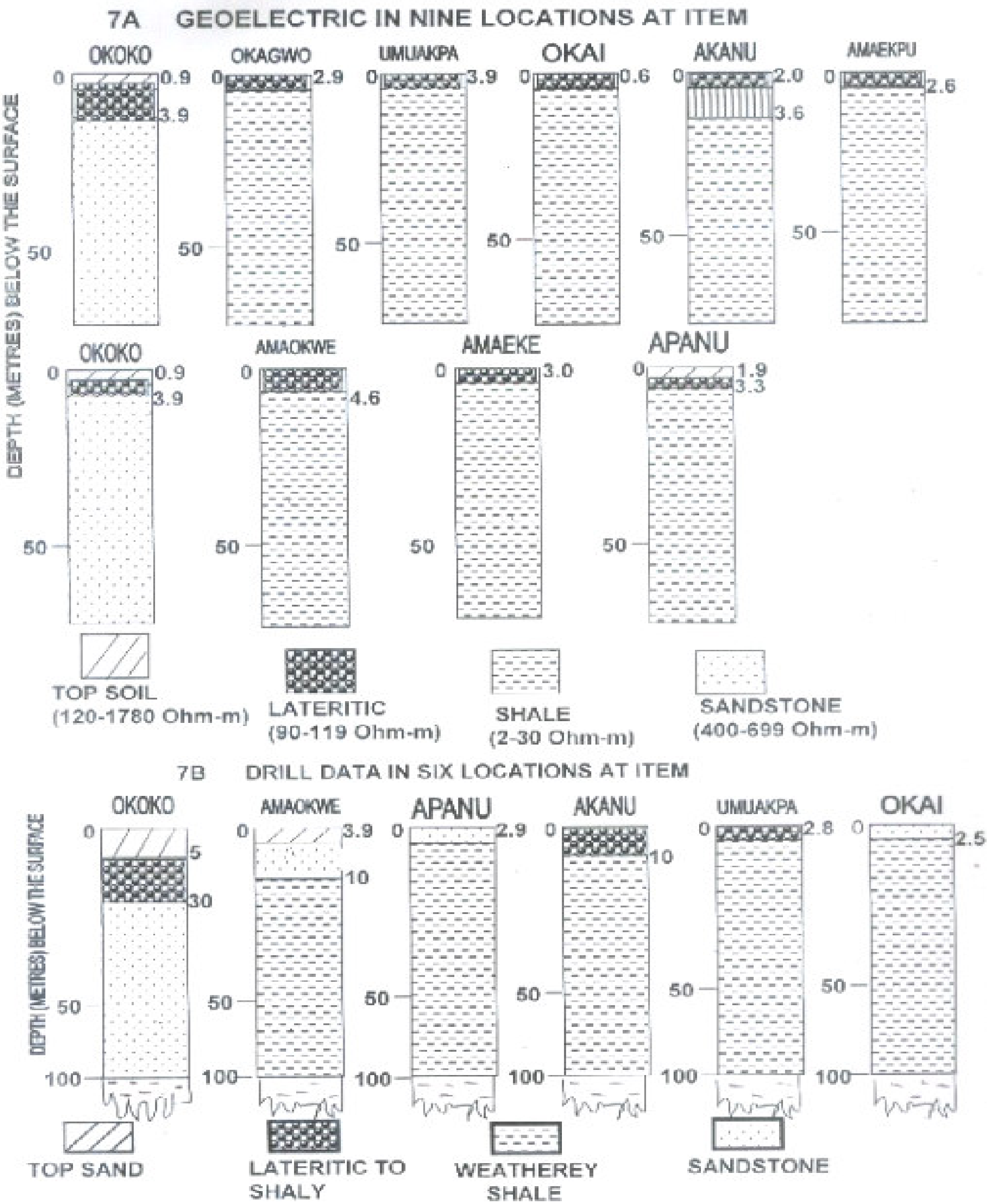


Figure 7. Geoelectric section in item area in comparison with drill data.

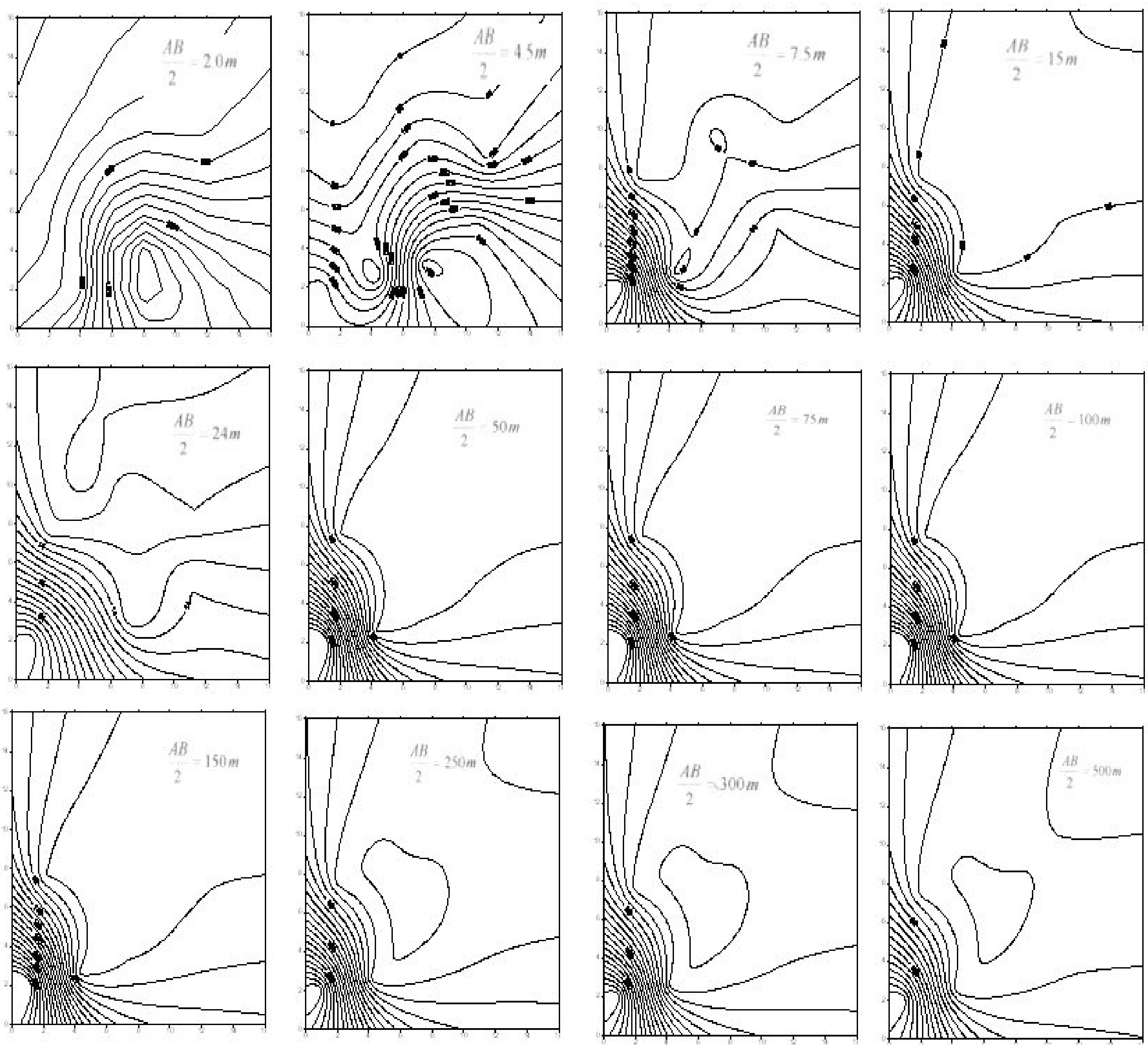


Figure 8. Equiresistivity contour map.

fence diagram, Figure 7, confirm the surface geology as discussed below.

AB/2 = 2.0 m

As a result of very shallow penetration of just 0.67 m the top soil matter in all the locations show high resistivity values due to dryness. Thus the geology is so displayed.

AB/2 = 4.5 m

Here there appears to be two separate closures, indicative of two main rock types, sandy shale and shale.

AB/2 = 7.5 m

At AB/2 = 7.5 m, equivalent to about 2.5 m penetration, the area in polarized into sandy and shaly ends, Figure 8. The presence of sandy and shaly units is clear in Okoko and other areas respectively Figure 8.

AB/2 = 15, 24, 50, 75, 100 and 150 m

There are closures within the Manu-Nkporo areas indicative of possible transitional effects in pure marine Nkporo and paralic Mamu Kogbe (1989). This type of electrically controlled data has been employed by Oteri (1982) in the delineation of saline contamination.

Ekwere et al. (1994) and Ibe, (1998) have also used similar plots to isolate limestone-shale sequence in the late Maastrichtian Nsukka formation in eastern Nigeria.

Comparison made between these contour maps and the geoelectic fence diagram, Figure 7, indicates clear demarcation between water-bearing Maastrichtian Ajali sandstone and the dry Mamu-Nkporo shaly areas. The famous Ahaba-Ohafia-Arochukwu water divide is located south of the area. The streams in the area flow from the South to the North. Thus most surface water sources rise from the sandy areas of the South, Figure 1. From the discharge rate measured in the surface water sources, the rates decrease northwards. This indicates the role played by the relatively shaly units in not releasing the water from this north bound streams. In 1984, a surface water plant was built in Apanu to supply water to the village. This was based only on geologic mapping of the rock units.

Conclusion

A combination of geologic mapping and electrical resistivity sounding data has proved very efficient in delineating water zones from areas without exploitable subsurface sources in Item area. The Southern parts of the study area prove to be sources of numerous streams in the study area and should be employed for productive wells. Already only Okoko village located in the Maastrichtian Ajali formation to the South and Southwest, has a produce well.

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