3D GEOELECTRICAL RESISTIVITY IMAGING FROM A 2D PROFILES TO INVESTIGATE THE SUBSURFACE LITHOLOGY IN UGBOWO AREA OF OVIA-NORTH EAST LOCAL GOVERNMENT AREA IN EDO STATE, NIGERIA

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ABSTRACT
This paper examine the effectiveness of 3D geoelectrical survey from a 2D profiles and delineate the Lithology of the study area. In this study, 2D and 3D resistivity imaging method were adopted to produce the images of the subsurface structure of the golf course area at the University of Benin, Edo state Nigeria. Orthogonal set of 2D geoelectrical resistivity field data was carried out using the Wenner Alpha configuration. The observed 2D apparent resistivity data were processed using a 3D inversion code. The 3D model resistivity images obtained from the inversion are presented in horizontal and vertical depth slices in contour and block images. This study was carried out to show the effectiveness of 3D geoelectrical resistivity imaging using parallel 2D profiles. The result shows some buried subsurface deposit from the survey which ranges from Alluvium soil, Shale, Slate, Sandstone , Quartz, Marble, Basalt, and Granite with apparent resistivity values ranging from 756 Ωm to 6988 Ωm extending to a depth of 74 m below the surface to the subsurface.

KEY WORDS: *Geoelectrical, Tomography, Three-dimensional, Two-dimensional, Subsurface.*

1. INTRODUCTION
The use of 2D and 3D geoelectrical resistivity imaging to address a wide variety of hydrological, environmental and geotechnical issues is increasingly popular. The subsurface geology in environmental and engineering studies is often subtly and multi-scaled [1], such that both lateral and vertical variations of subsurface properties can be rapid and erratic. The use of VES is grossly inadequate to map such complex and multi-scale geology. 2D geoelectrical resistivity imaging in which the subsurface is assumed to vary vertically down and laterally along the profile but is constant in the perpendicular direction has been used to study areas with moderately complex geology. All geological structures and spatial distribution of subsurface petrophysical properties are inherently 3D in nature. The 3D effects of subsurface structures are more pronounced in environmental and engineering investigations where the geology is highly heterogeneous and subtle. Model images resulting from 2D resistivity surveys often contain spurious features due to 3D effects and violation of the 2D assumption. This usually leads to misinterpretation of the observed anomalies in terms of magnitude and location [2], Hence a 3D survey with a 3D interpretation model in which the resistivity is allowed to vary in all directions should in theory give the most accurate and reliable results especially in subtle heterogeneous subsurface.
Resistivity surveying requires the introduction of artificial source of current into the ground through two current electrodes or long line contacts while two potential electrodes record the resultant potential difference between them in the vicinity of the current flow. This enables us to measure the electrical impedance (ratios of potential to current) of the subsurface material [3] (Ezema, 2004). The resistivity of the subsurface is a function of the magnitude of the current, the recorded potential difference and the geometry of the electrode array. Resistivity measurements vary with depths which depend on the saturation of the current and potential electrodes in a survey. The interpretation is in terms of Lithology or geohydrologic model of the subsurface. This paper is aimed to examine the subsurface Lithology of the study area using 3D geoelectrical model from 2D profiles.

FIELD DESIGN
The field design is the square grid, where the entire configuration is the wenner Alpha. Figure 1 shows the field design.

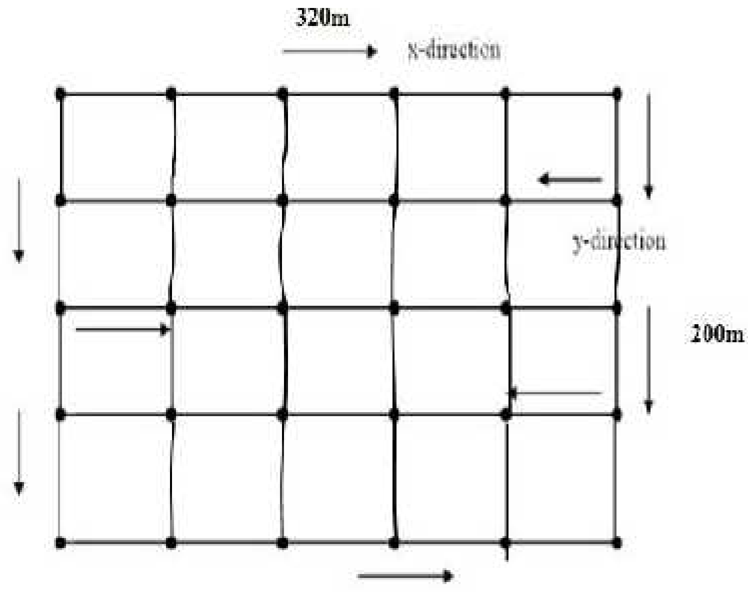

Figure 1: Field design (square grid)

2. LOCATION OF THE STUDY

This work was carried out at the university of Benin Golf course, in ovia North-East Local Government Area of Edo State Nigeria.

Figure 2: A pictorial view of the study area. (Source: Google – Earth)

3. MATERIALS AND METHOD

2D electrical resistivity data was acquired in the field using the wenner alpha configuration with parallel lines of 320 m with a field design of square grid format. The synthetic apparent resistivity data computed for the series of approximated 2D model structures were then collated into 3D data set format that can be read by RES3DINV (a full 3D inversion computer code) using RES2DINV inversion software. Parallel 2D and orthogonal 2D sets were collated separately into 3D data sets. The collation was done by supplying the line parameters including line directions and coordinates, electrodes positions, number of electrodes, and data levels of each 2D profile constituting the parallel and orthogonal sets in a text file that can be read by the RES2DINV program used for 2D data inversion.

INVERSION OF 3D DATA SETS

The collated 3D data sets were inverted using RES3DINV computer code which automatically determines a 3D model of resistivity distribution using apparent resistivity data obtained from a 3D resistivity imaging survey [4] [5]. Ideally, the electrodes used for such a survey are arranged in squares or rectangular grids.

4. RESULTS

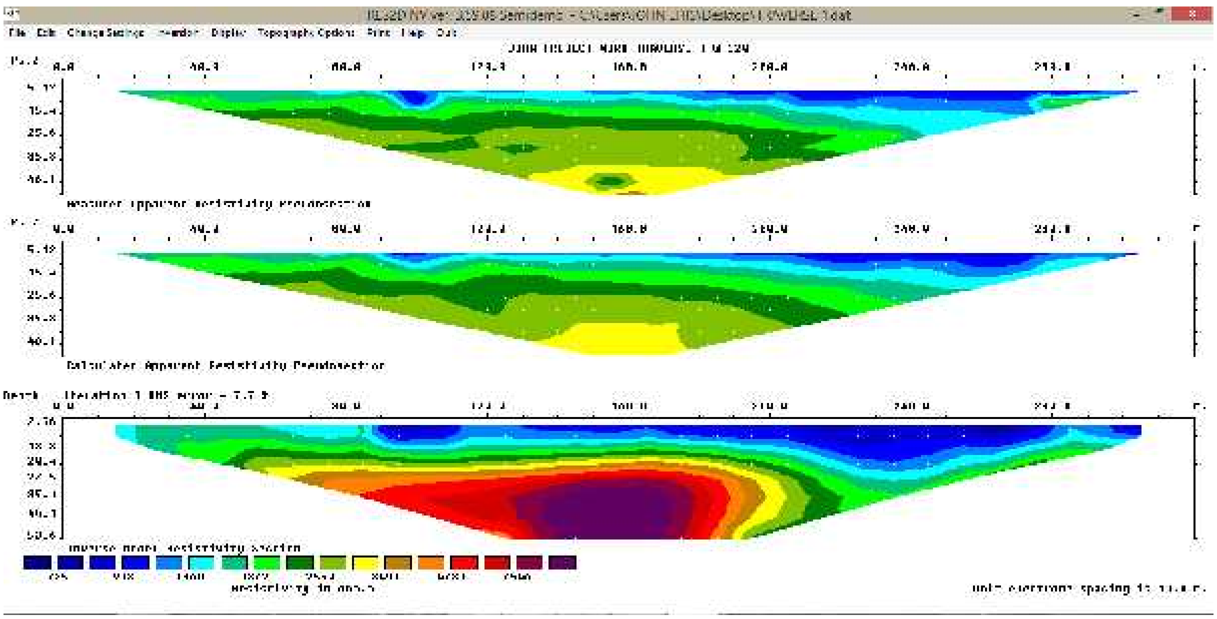

Figure 3: Inverted 2D resistivity model obtained for traverse one

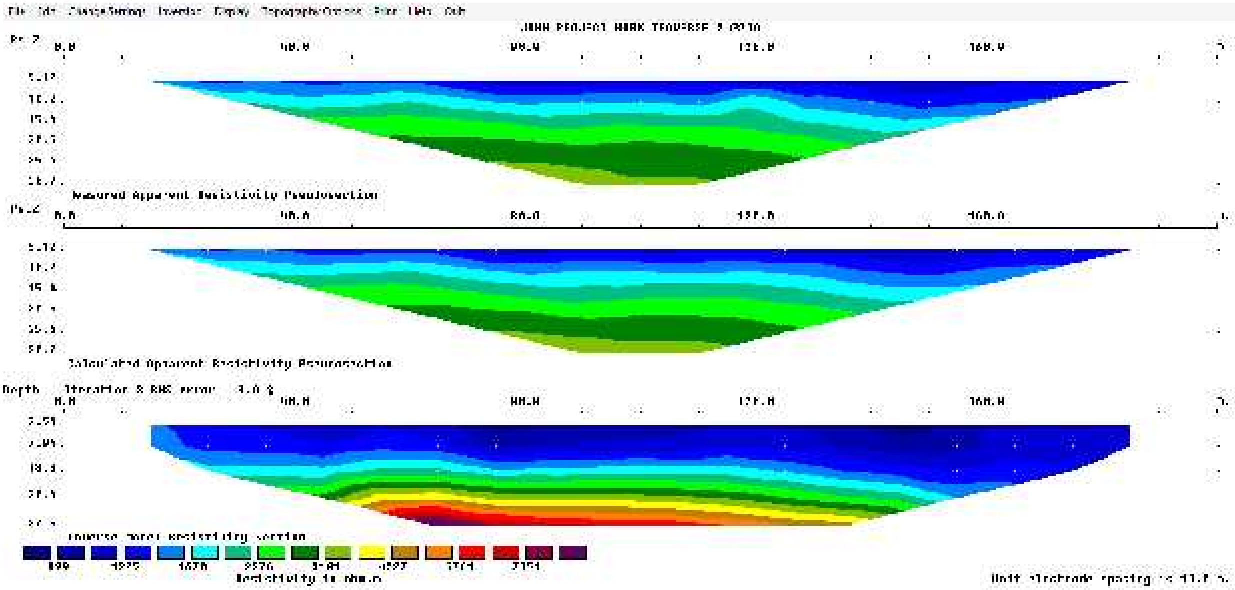

Figure 4: Inverted 2D resistivity model obtained for traverse two

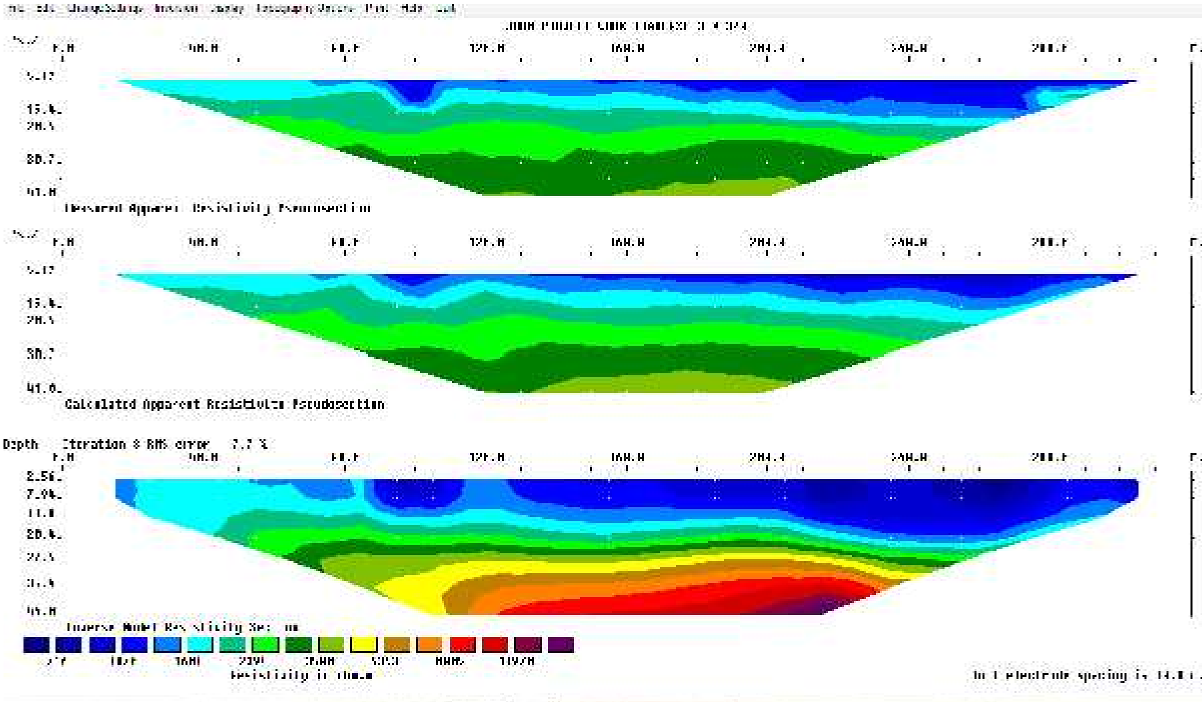

Figure 5: Inverted 2D resistivity model obtained for traverse three

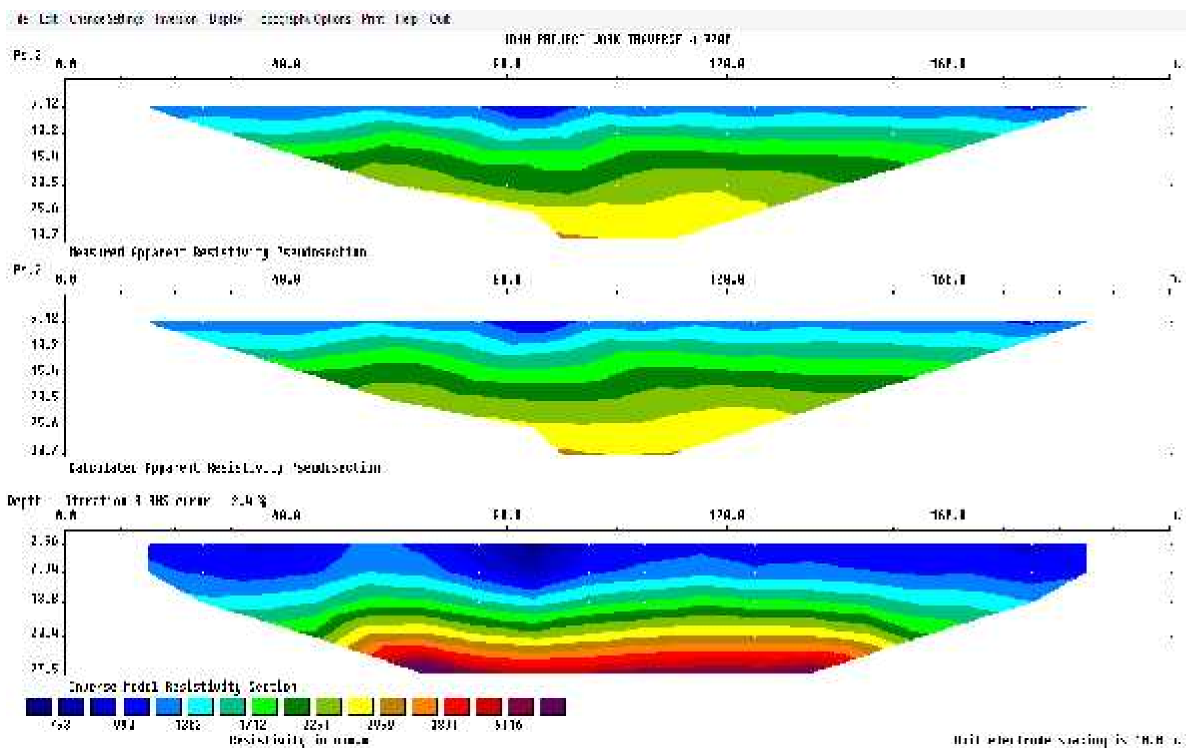

Figure 6: Inverted 2D resistivity model obtained for traverse four

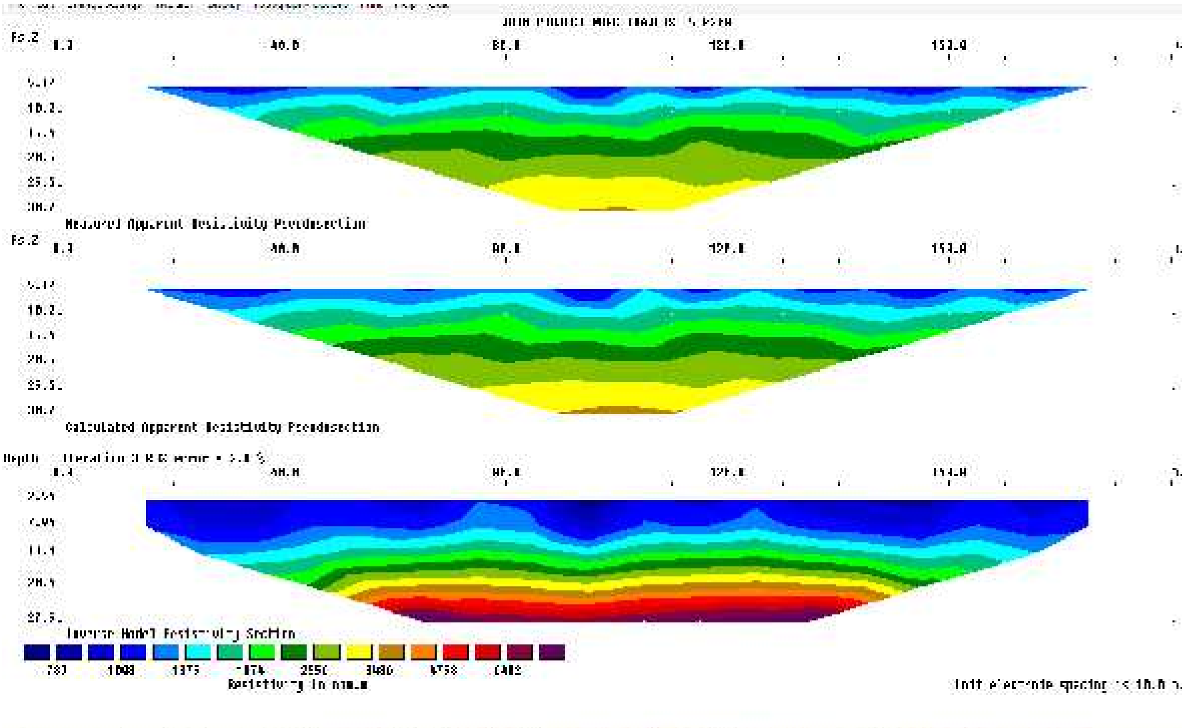

Figure 7: Inverted 2D resistivity model obtained for traverse five

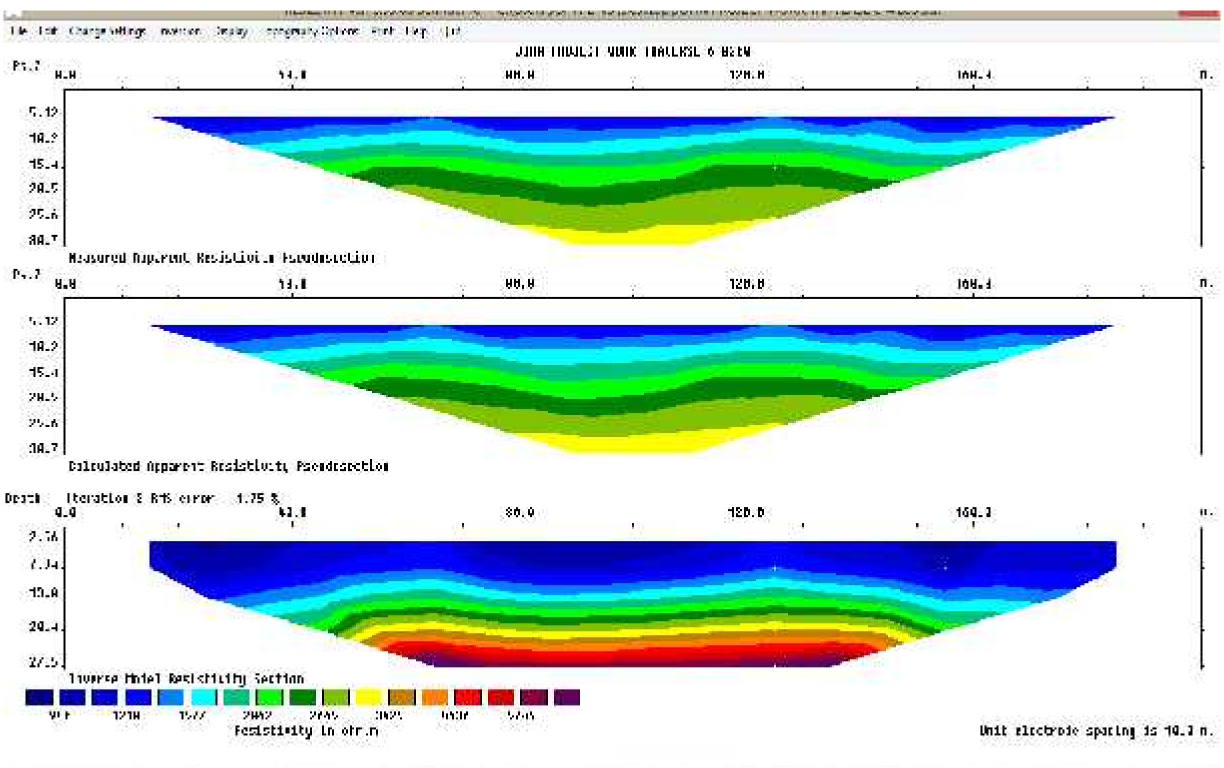

Figure 8: Inverted 2D resistivity model obtained for traverse six

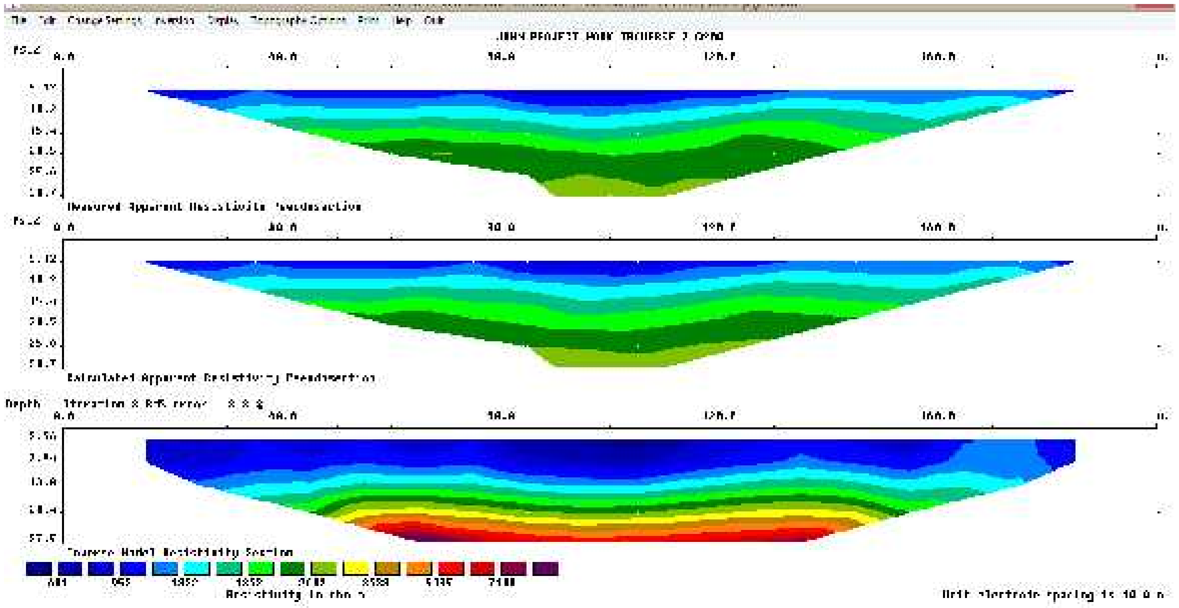

Figure 9: Inverted 2D resistivity model obtained for traverse seven

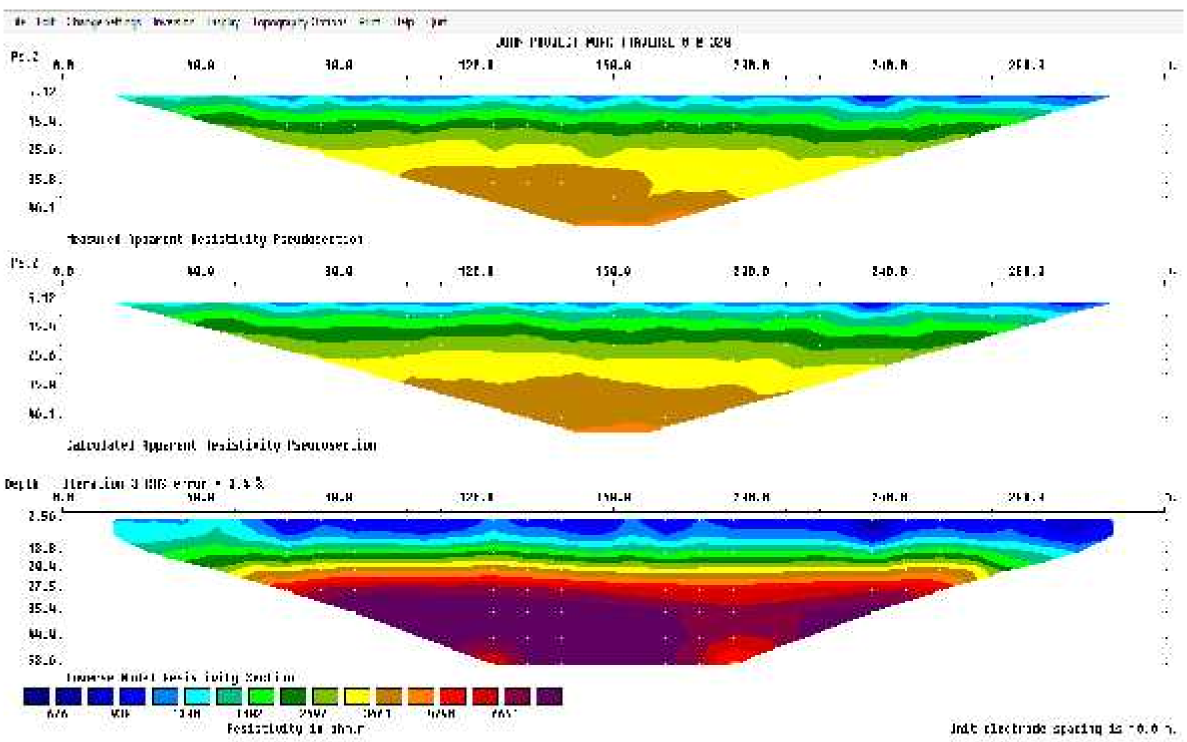

Figure 10: Inverted 2D resistivity model obtained for traverse eight

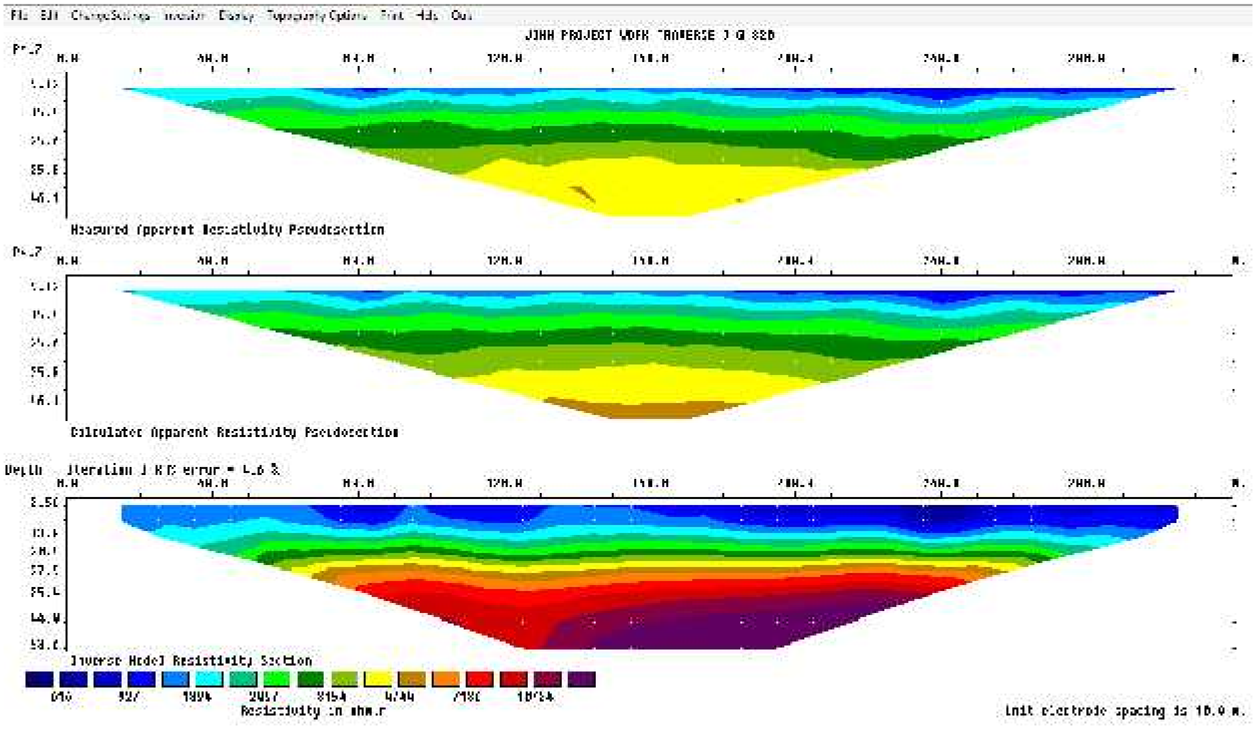

Figure 11: Inverted 2D resistivity model obtained for traverse nine

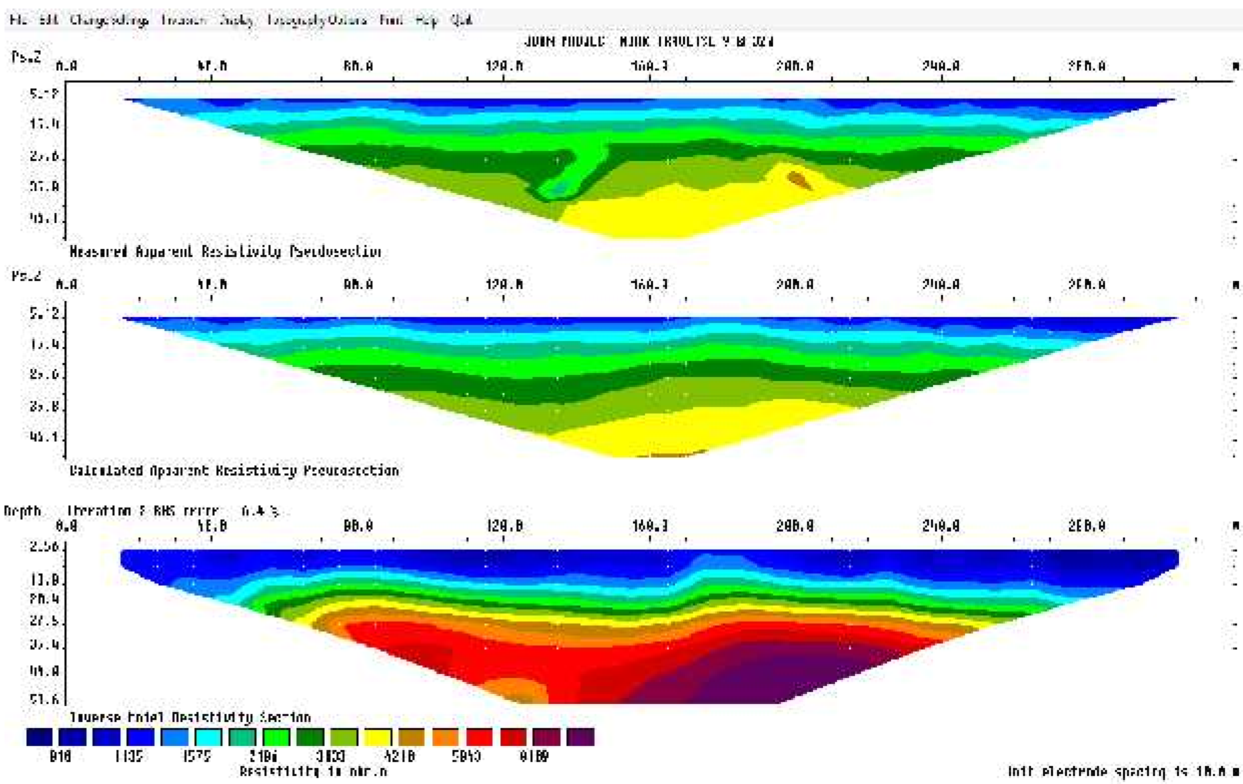

Figure 12: Inverted 2D resistivity model obtained for traverse ten

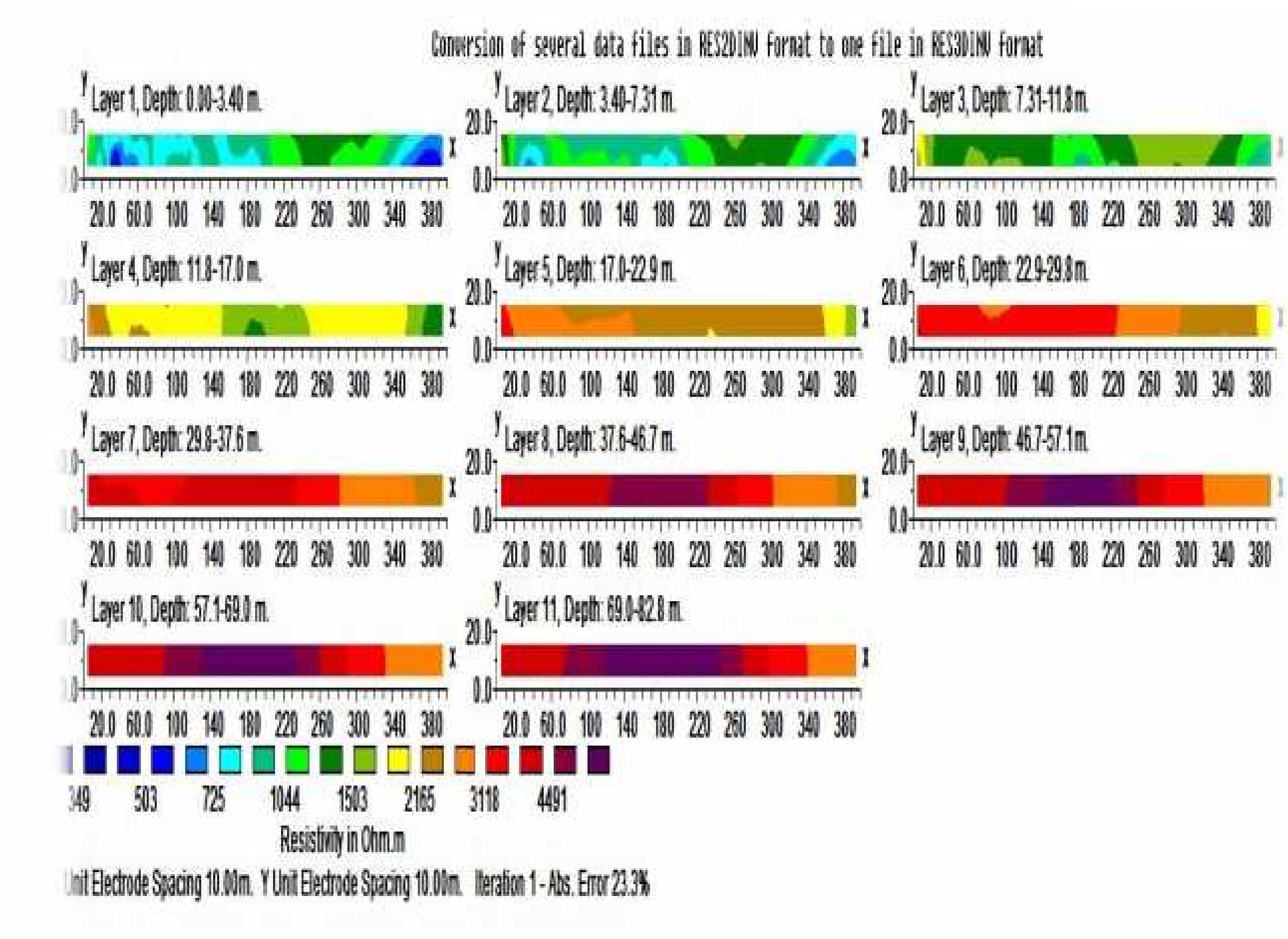

Figure 13: Inverted 3D slices obtained from the study area.

5. DISCUSSION OF RESULT

Figures 3 – 12 shows the 2D inverted imaging model and figure 13 is the inverted 3D slices obtained from the study area. The subsurface images from the 2D model reveals eight distinct subsurface layers ranging from Alluvium soil, Shale, Slate, Sandstone , Quartz, Marble, Basalt, and Granite with apparent resistivity values ranging from 756 Ωm to 6988 Ωm. The delineated subsurface Lithology materials extend to a depth of 74 m below the surface towards the end of the depth of investigation. It will be observed, that there is an increase in the coarse nature of the Lithology rocky materials which is reflection from the increase in resistivity of the rock types as we go deeper into the earth subsurface of the study area.

Table 1 shows the summary of the different Lithology types in rock formation from the study area with their resistivity as compare with standard resistivity table.

Table 1: Summary of the inferred Lithology (rock types) in the study area.

Resistivity(Ωm)	Inferred Rock Type	Standard Resistivity in (Ωm) values for rocks.
420-2000	Alluvium (soil)	10 – 800
420-5000	Shale	$20 - 2x10^3$
600-6988	Slate	$6x10^2 - 4x10^7$
2000-6988	Sandstone	$8 - 4x10^3$
2000-6988	Quartz	$10^2 - 2x10^8$
2000-6988	Marble	$10^2 - 2.5x10^8$
3000-6988	Basalt	$10^3 - 10^6$
3233-6988	Granite	$5x10^3 - 10^6$

3D geoelectrical resistivity images have increased the degree of reliability of the geoelectrical resistivity imaging technique. The use of parallel 2D profiles in generating 3D data set is a fast and effective technique of conducting 3D geoelectrical resistivity surveys. The resolution of the inversion images can be enhanced by using closely spaced 2D profiles or orthogonal 2D profiles. The inverse models are, however, characterized with grid orientation effects which can be misleading in subsurface features interpretation and also unrealistic artifacts and spurious features due to 3D effects commonly associated with 2D inversion images are minimized or completely eliminated in the 3D inversion images.

6. CONCLUSION

The 2D geoelectrical resistivity survey in Ugbowo area in Ovia-North East LGA has help to delineate the subsurface Lithology of the area. It is evident from the result of the modeled 2D images, that the Lithology is rich in some buried rocks materials which reveal Alluvium soil, Shale, Slate, Sandstone, Quartz, Marble, Basalt, and Granite.

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