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APPLICATIONS OF 2D ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT) TECHNIQUES TO SITE INVESTIGATIONS AT IGUOVIEMWEN COMMUNITY SOUTH-SOUTH NIGERIA.

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ABSTRACT

Geophysical investigations involving the use of 2D electrical resistivity tomography (ERT) techniques have been used to carry out site investigations at Iguoviemwen Community Southern Nigeria, to study the nature of the subsurface so as to assess its suitability for the construction of heavy structures. Five (05) high resolution 2D electrical resistivity images were acquired using the Wenner configuration array method with minimum electrode separation of 5m. The Abem terrameter SAS 4000 was used to carry out the study and RE2DINV software was used to analyze and invert the acquired data. A profile length of 200m was surveyed and an average depth of 39.6m and 57.2m were covered at the study location. The results revealed the presence of 3 main geoelectric layers beneath the subsurface. Which were identified as top Layer, consisting mainly Laterite and some pockets of Clayey Soil, the Middle Layer which consisted of Compacted coarse and Dry Sand and the bottom Layer which consisted mainly of Sandstones.

1. Introduction

Without high-level site studies, it is impossible to create a modern super structure building. These investigations are crucial to maximizing both design and cost. Any development project should start with a site investigation as a requirement [1]. Engineering geophysics is a productive way to look underneath the surface. It entails using geophysics to solve geotechnical engineering problems. Examples of its applications include finding cracks, weak zones, expanding clays, water table, layer boundaries, bedrock depth, and rock type.

[2] Engineering is used in Estimating the stiffness, density, electrical resistivity, porosity, and other characteristics of Earth's materials is made easier by geophysics. These studies are required to prevent future risks, such as the collapse of a structure and the resulting loss of finance.

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The fastest and least expensive method for gathering subsurface data is geophysical surveying. The subsurface geology in environmental and engineering studies is frequently multiscale and slightly heterogeneous, meaning that alterations in the subsurface characteristics can occur quickly and randomly on both the lateral and vertical axes. For mapping such complicated and multi-scale geology, vertical electrical sounding is a woefully insufficient method.
Areas with moderately complex geology have been investigated using two-dimensional (2D) geoelectrical resistivity imaging, where the subsurface is assumed to vary vertically down and laterally along the profile but constant in the perpendicular direction [3-7]

GEOLOGY OF THE AREA

The study area is located in Nigeria's Niger Delta Basin. The area is between 0727120 (5° 3′ 27.77′′ E) in the east and 07° 24′ 38.76′′ N in the north (7° 25′ 6.02′′ N) in the east. The terrain is rolling, moderately undulating, with vegetated, steep ridges. The study area's surface is made up of dry lateritic sand. It is composed of a thin (1 m) layer of topsoil surface sand. Edo State is located in the Niger Delta geological region. [8] described the thick continental sands that make up the Benin formation. It stretches southward past the current coastline and from the west across the entire Niger-Delta region.

THEORY AND METHODS

The purpose of the resistivity survey was to evaluate the site's potential for the construction of large structures. The ABEM Terrameter SAS 4000 was utilized to measure the apparent resistivity (ρa). This instrument is equipped to conduct sounding, SP, IP, and resistivity profiling surveys. In order to detect the potential difference between the two potential electrodes and apply Ohm's law, the resistivity method makes use of two current electrodes that inject current into the ground.

$$V=IR \qquad 1$$

Where V= Voltage, I = Current and R is the resistance

After calculating the resistance, the apparent resistivity was determined by multiplying the resistance by a geometric factor K that depends on the array. When comparing a Schlumberger array and a gradient array at the same place, the latter would display a different apparent resistivity model. Consequently, the following equation can be used to represent the apparent resistivity:

$$\rho a = 2\pi \, (\Delta V/I) * (1/G) \qquad 2$$

where G is the geometric factor, which varies from array to array and is defined as the spacing between the current and potential electrodes (m), ρa is the apparent resistivity measured in (Ω*m), and ΔV/I is the change in potential difference over current (Ω) [9]. The electrode selector evaluates the apparent resistivity between two pairs of electrodes—two current and two potential—by automatically selecting them each time. Before the measurement begins, the electrode separation is continuously increased in accordance with the instrument's instructions. Using this technique, the device uses the identical a-spacing and n-factors for a Wenner array to produce a depth profile at the electrodes' midway. Two electrode cables, each 48 meters long and with an electrode taken every 5 meters, were used to set up the profile lines, totaling 40 meters in length. The primary display unit is connected to the electrode selector (Automated ES 46-10C) via the two electrode connections. An external automobile battery (14V, 900Ah) powers the main device, enabling a wide range of measuring requirements. The profile lines were set up using stainless steel electrodes, which help to dampen noise around the electrodes. The electrodes were buried between two and three meters into the ground to provide a low possibility of noise caused by the electrodes. In order to guarantee correct contact between the electrodes and the ground, water the region adjacent to the electrodes. With crocodile clippers, the electrodes were attached to the cable takeout. The instrument's and the clippers' connectors were routinely cleaned of dirt and oxide to ensure long-term instrument functionality, as this could compromise the accuracy of the measurements. Since the inversion program would not recognize the DC resistivity values that were acquired in the field in the.s4k format, software called Erigraph was used to convert the data from the.xyz format into the.dat format, which the RES2DINV software could handle with ease.

RESULTS AND DISCUSSIONS

Profile 1

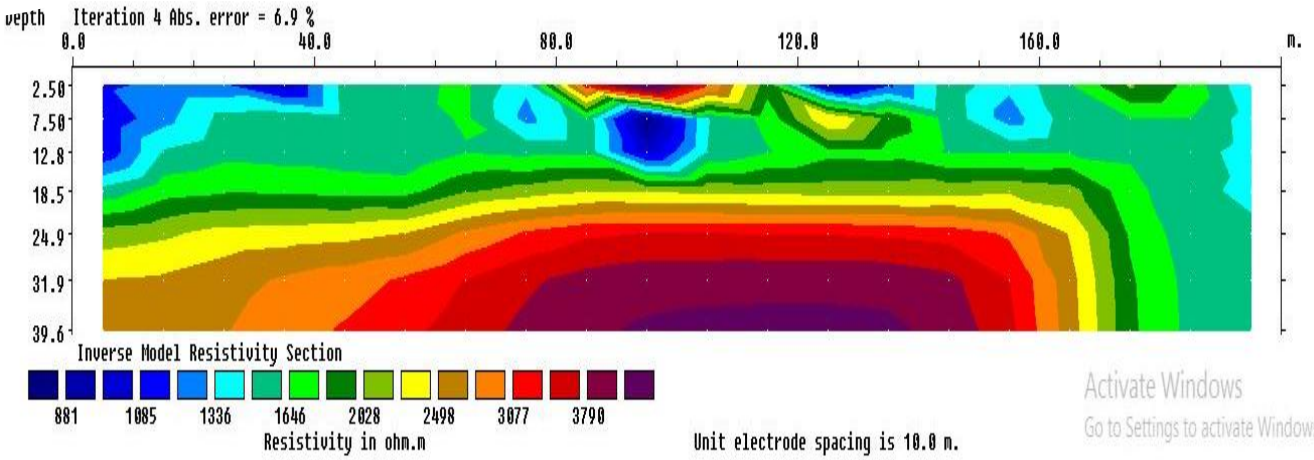

Figure 1: Inverse 2D Model Resistivity section along Profile 1

Profile 2

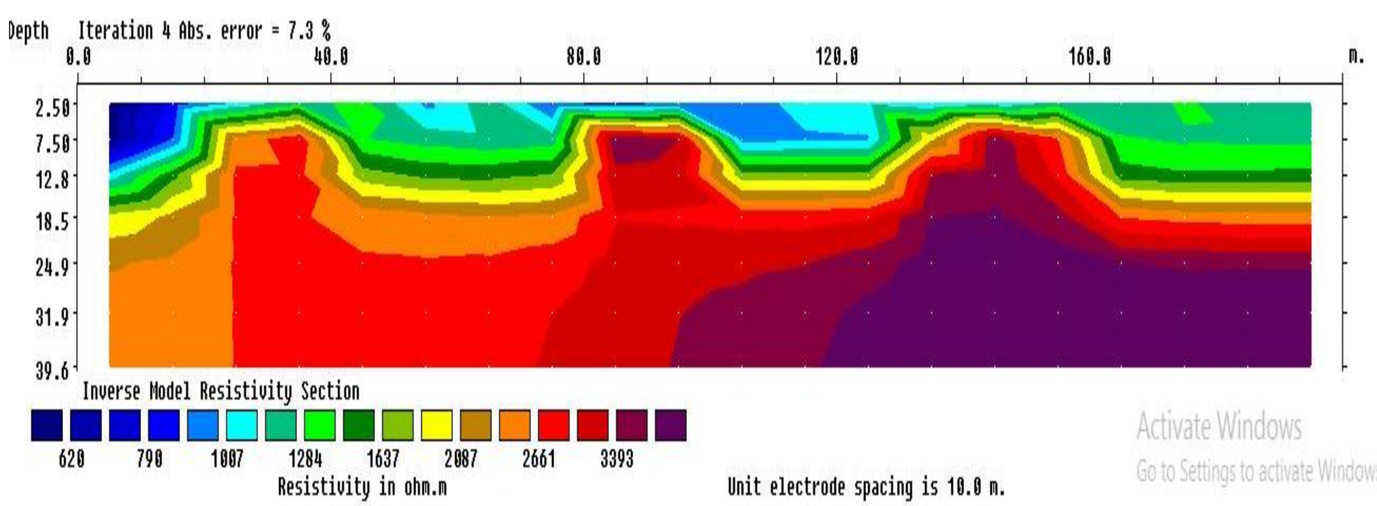

Figure 2: Inverse 2D Model Resistivity section along Profile 2

Profile 3

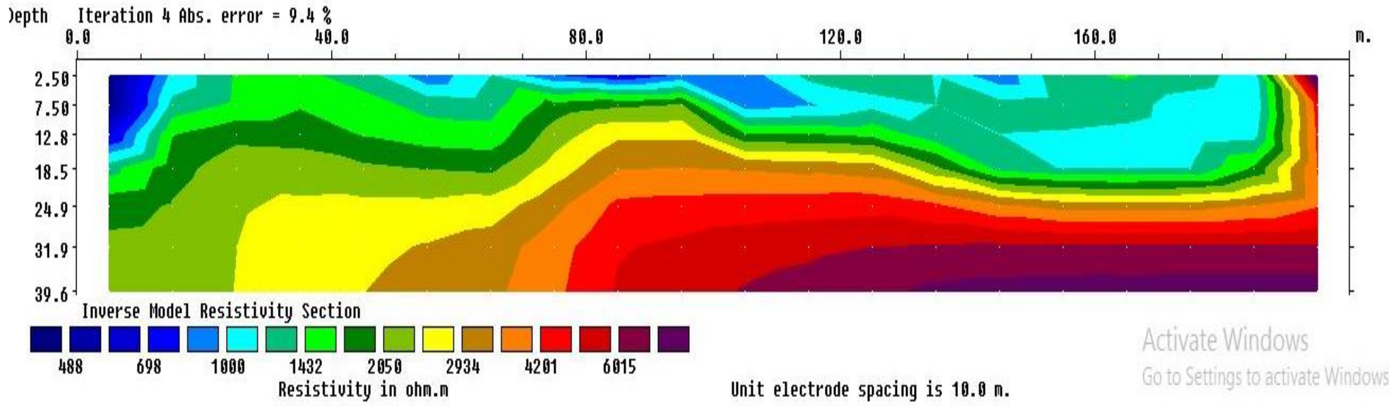

Figure 3: Inverse 2D Model Resistivity section along Profile 3

Profile 4

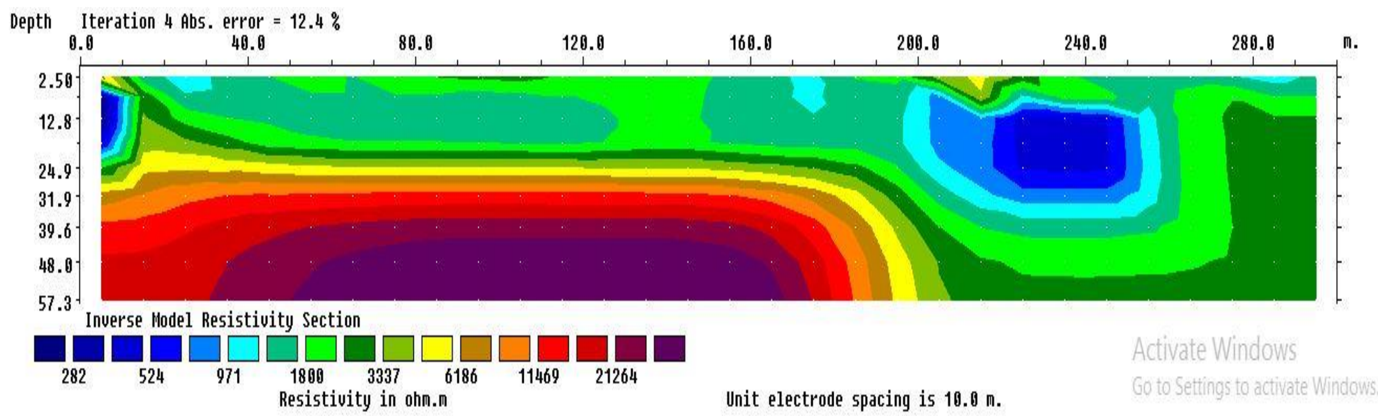

Figure 4: Inverse 2D Model Resistivity section along Profile 4

Profile 5

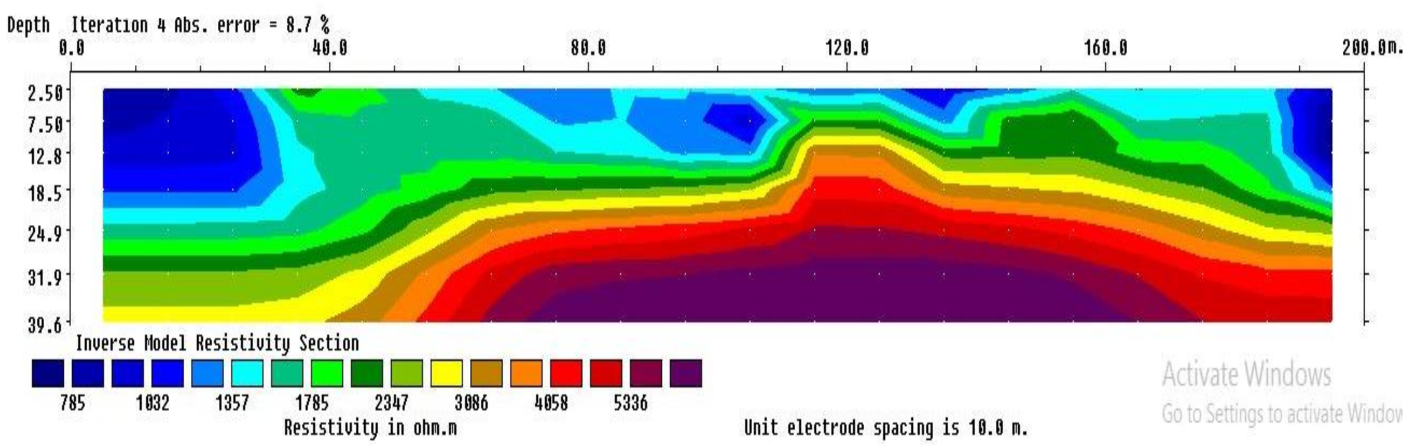

Figure 5: Inverse 2D Model Resistivity section along Profile 5

DISCUSSION OF RESULTS

The obtained electrical resistivity images of the subsurface of the 5 profiles are presented as inverted models in figures 1,2,3,4 and 5. The root mean square errors obtained in the inverted models were between a minimum of 6.9% to a maximum of 12.4 %.

There is a good correlation between the subsurface images. The profile length of each of the profiles were 200m and a surveyed depth of 39.6m except for Profile 4 which had a profile length of 300m and a surveyed depth of 57.2m. Profile 1 and 2 had a top show which consisted of suspected accumulations of Lateritic soil with resistivity of 750ohmm to 1500ohmm this suspected soil stretched up to 18m in depth across the profile before deeping down at the western end of the survey line. At depth 20m to 39.6m the two profiles exhibited the same formation showing highly compacted soil which is suspected to be coarse sand and Sandstones with resistivity ranging from 1600ohmm and above. Profile 3 and 5 also exhibit similar features with profile 1 and 2 however the depth of the top soil extended a bit further down in profile 5 to about 24.9m across the profile with suspected Laterite deposits and clayey soil. The suspected Compacted Coarse sand and sandstones is also evidently seen in profile 3 and 5 from 25m to 39.6m in depth across the profiles. Profile 4 which has a profile length of 300m and depth of 57.3m however slightly varies with the accumulation of suspected clay materials the western end of the profile. This suspected clay formation stretches from to top soil up to 30m in depth. Other suspected features present in the other profiles are also evidently shown in the profile.

CONCLUSION

The 2D ERT was carried out at Iguoviemwen Community South-south Nigeria. The results revealed the presence of 3 main geoelectric layers beneath the subsurface. Which were identified as top soil, consisting mainly Laterite and some pockets of Clayey Soil, the Mid Soil which consisted of Compacted coarse and Dry Sand and the Lower soil which consisted mainly of Sandstones. It has been observed here that rich aquifer formation cannot be found with the surveyed depth as one my need to probe further. This provides additional support for the ERT approach, which was employed in the inquiry and is a useful addition to engineering soil tests for geotechnical site investigation. Resistivity surveys penetrate significantly deeper than percussion drills, which are typically used in geotechnical investigations.

Furthermore, resistivity tomography showed a broad lateral coverage in contrast to geotechnical approach point observation. This offers a clearer picture of the subsurface and more space for improved engineering for the structure's foundation in the research region.

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