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Electrical Resistivity Characterization of Peat and Clay Profiles at a Suburb of Ota, Southwest Nigeria

Olawale Babatunde Olatinsu*, Segun Opeyemi Olawusi and Mathew Osaretin Ogieva
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Abstract: *Typical soft soils such as peat and some clay types have long been of great interest in geotechnical engineering as a result of their deficient hydraulic and mechanical qualities. These soils are prone to volumetric change and collapse especially in wet conditions and when loaded. Due to the need for expansion of modern cities, highways and roads have occasionally had to pass through locations underlain by pockets of these collapsible soils. In environments such as this, assessing and evaluating subsurface conditions before the start of engineering work becomes crucial. A geophysical survey involving 2D electrical resistivity imaging (ERI) and vertical electrical sounding (VES) techniques was conducted to map the spatial distribution of peat and clay zones at Koro Otun, in the vicinity of the Idiroko-Ota Highway. Twelve acquisition layouts consisting of 40 sounding stations and 12 resistivity imaging traverses were occupied using Schlumberger and Wenner electrode configurations respectively. The results obtained reveal the presence of a very thin topsoil layer at a depth of less than 1 m in almost all surveyed locations. Peat soil characterized by resistivity and thickness in the ranges 8.8 – 9.7 Ωm and thickness 6.2 – 17.8 m respectively, was delineated at 6 locations (15 %) along 3 traverses at shallow depths of 7.8 – 24.7 m. Clay with resistivity ranging from 10.3 to 47.4 Ωm and thickness range of 1.9 – 34.8 m has more occurrences at 21 sounding stations (53 %) across 9 traverses at varying depths of 2.4 – 39.2 m, with 11 stations indicating the absence of both peat and clay. Less competent sandy clay lies beneath some places, while more competent sand or clayey sand lies beneath a few others. Deep-lying clay zones at depths greater than 20 m but less than 40 m were delineated at a few locations. Both peat and clay zones occurred mostly in the second and third subsurface layers, except at five sounding stations where clay occurred as the last layer. ERI spatial distribution depicts soft soil zones in the form of ridge/mound, trough/depression, horizontally stratified column and trapped bed along several traverses. ERI also reveals laterally extended but discontinuous distribution of clay and pockets of peat zones at a few identified locations. Even though the roads in the Idiroko border town and its surrounding areas are exposed to huge vehicular traffic, primarily from heavy-duty trucks, their lifespan and durability can still be increased if appropriate subsurface geophysical investigations are given proper consideration and their recommendations implemented before the building of roads, bridges, and other transportation facilities.*

Keywords: *Electrical resistivity, map, peat, clay, delineation*

Olawale Babatunde Olatinsu*
Department of Physics, Faculty of Science, University of Lagos, Lagos, Nigeria.
Email: oolatinsu@unilag.edu.ng
Orcid id: 0000-0002-0412-1972

Segun Opeyemi Olawusi
Department of Physics, Faculty of Science, University of Lagos, Lagos, Nigeria.
Email: olawusisegun1@gmail.com

Mathew Osaretin Ogieva
Physics Department, Faculty of Science and Art, Cleveland State University, Cleveland, Ohio, USA.
Email: m.ogieva@vikes.csuohio.edu
Orcid id: 0000-0003-4010-9011

1.0 Introduction

Peat and clay occur under diverse geological and hydrogeological conditions in many parts of Nigeria's sedimentary environment especially in the southwest and Niger Delta regions. These soils have been of great concern in the building and construction industry due to certain intrinsic characteristics such as high compressibility, low shear strength, low permeability, large void ratio and high water content (for peat). Therefore, the sitting of high-rise structures, transportation infrastructure, and other engineering projects for both urban and rural areas on these soils will pose some difficult challenges. This calls for thoroughness and depth in the aspect of preconstruction planning, analysis and design, and postconstruction maintenance of proposed facilities in areas where these problematic soils are present. Given the numerous large-scale infrastructure and development projects being carried out in nations all over the world, it may become necessary for engineering structures to travel over geological formations that are covered in peat, clay, silt, mud, and other materials, particularly in wetland and coastal areas (Omar and Jaafar, 2000; Bulleri and Chapman, 2010; Almeida and Riccio, 2012; Wang et al., 2019; Staszewska and Cudny, 2020; Jordan and Fröhle, 2022; Kong et al., 2022). However, the utilization of geophysical procedures can be of advantage in the design and construction of infrastructure on the ground underlain by problematic soils. The most significant feature of soft soils in terms of geotechnical issues is their significant compressibility, which is highly harmful to geoengineering constructions (Abdel-Salam, 2018; Salimi, and Ghorbani, 2020). Unstable and collapsible soils typically contain a very high proportion of clay minerals (Salimi, and Ghorbani, 2020). In some environments, they are close to the water table and have high moisture content, loose sand deposits, and silty and clayey elements with high proportions of fine particles (Kamon and Bergado, 1991; Williams-Mounsey et al., 2021). Any soft soil with a high organic content, fine grains, and clay content is primarily compressible and has a limited bearing capacity. As a result, they frequently cause differential settlement, which poses a major risk to the stability of facilities and infrastructure (Asaoka, 1978; Bell et al., 1995; O'Kelly, 2006; Bujang, 2014; O'Kelly, 2017; Olatinsu et al., 2019; Williams-Mounsey et al., 2021; BGS Research, 2023). In addition, the shrink-swell behaviour of expansive soils has been established as the most damaging geohazard in geotechnical works globally (BGS Research, 2023). Shrinkage can lead to differential settlement or subsidence. More importantly, shrinkage resulting from drainage coupled with a decrease in the base volume are important features of organic soils that are of interest in civil and geotechnical works (Bell et al., 1995; Schwärzel et al. 2002; Tonks and Antonopoulos, 2015). About 50 % of the global wetlands are peatlands with a common occurrence in most African countries (Lappalainen and Zurek, 1996; Smuts and Akiaoue, 1999; Grundling and Grootjans, 2016). Peat is formed through the accumulation of decomposed plant remains usually in a waterlogged environment where oxygen is insufficient (Schwärzel et al. 2002; El-Qady et al., 2005; Sjöberg et al., 2015; O'Kelly, 2017; Mustamo et al., 2016; Kunarso et al., 2022). High acidity and leaching of humus are also common with peat soil (Mustamo et al., 2016; Sutejo et al., 2017; Carlson et al., 2015). In Nigeria, the Niger Delta and other prominent swampy areas in the southern regions have a significant number of peatlands (Akpokodje, 1989). Peat soil, in particular, is highly heterogeneous and represents the extreme form of soft soil recognized as one of the most challenging and problematic soils for engineering structures (Wang et al., 2019; Hamid and Alia, 2022). Furthermore, soil problems often encountered at sites have been found to increase with increasing volume and depth of peat (Young et al. 2018; Menberu et al., 2021).

Geotechnical testing is frequently used to get information on soil engineering qualities. The results must be extended or interpolated over a larger territory because economic considerations and implications frequently restrict the number of test locations. However, the application of geophysical techniques in environmental and civil engineering has grown in recent times and has assisted in the generation of precise extrapolation and interpolation of soil geotechnical parameters (Ward 1990; Cosenza et al., 2006; Sultan and Monteiro Santos, 2007). Non-invasive geophysical methods such as electrical resistivity survey offer the capability and possibility of mapping the stratigraphy and spatial distributions of soft soil in diverse geological environments because of the possible correlation that exists between electrical properties (such as resistivity or conductivity) and geological features of Earth materials (Telford et al., 1990; Kearey et al., 2002; Slater, and Reeve, 2002; Lowrie, and Fichtner, 2020; Pezdir et al., 2021). In addition, direct current resistivity surveys involving vertical electrical sounding (VES) and electrical resistivity imaging (ERI) are proven tools for the mapping of peat and clay because (i) the characteristic low resistivity signatures of peat and clay will most clearly distinguish them from surrounding subsurface materials with relatively moderate and high resistivities (Meyer, 1989; Reynolds, 2011); and (ii) variations in both lateral and vertical heterogeneity of subsurface geological structures often manifest as different forms of engineering problems on road and other infrastructure. The current study focuses on the use of VES and ERI to map and delineate subsurface conditions along a different route that may be used as a quicker lane to reach the border town of Idiroko on the way to the Republic of Benin rather than the high-traffic Idiroko-Ota Highway. This is required to give valuable scientific data that will support future road network maintenance and renovations within the study area.

1.1 Description, geology and hydrogeology of the study area

The study location is situated within Koro Otun community in Ota, Ado-Odo/Ota local government area of Ogun state (latitude 6°41′00″ N and longitude 3°41′00″ E), south-west Nigeria. Ado-Odo/Ota LGA is the second largest in Ogun state and has a boundary to the south with metropolitan Lagos state. Many roads in the area, such as the Koro Otun gorge receive heavy vehicular traffic every day apparently because it connects to many important places such as the international border at Idi-Iroko, Agbara Industrial Estate, Winners Chapel and the Lagos State University of Education (LASUED) in Oto-Ijanikin. The study area is moderately populated with the majority of the outer and inner roads in a very dilapidated and deplorable state.

Ota is a gently sloping low-lying area within the eastern Dahomey Basin of southwestern Nigeria which extends along the continental margin of the Gulf of Guinea. The local geology is dominated by the Dahomey Basin sedimentary rock sequence (Fig. 1), which extends from eastern Ghana through Togo and the Benin Republic to the western margin of the Niger Delta (Onuoha, 1999). The local geological sequence in the area includes the Recent Alluvium (Quaternary age) which covers the south-eastern and central regions reaching a boundary with Coastal Plain Sands in the west. This is followed by Coastal Plain Sands (Tertiary age – Pliocene) whose locations in the west, southwest and eastern parts are bounded by the Ilaro Formation in the northwest. The Ilaro Formation (Tertiary age - Eocene) which cut across north-west to north-east of the study area, overlies both the Coastal Plain Sands and Recent Alluvium and is underlain by a sequence consisting of Ewekoro/Oshosun/Akinbo Formations (Cretaceous – Paleocene), which cuts across north-north to north-east trend. The last geological formation directly beneath the Ewekoro Formation is the Cretaceous (Senonia) Abeokuta Formation having a boundary with the Basement Complex in the north (Omatsola and Adegoke, 1981). The Hydrogeology of the Dahomey Basin encompasses the Ogun River and Owena

Basin. The tectonic structure of the basin is not too complex, yielding a monocline towards the basement outcrop to the North, with only little or no evidence of faulting (Omatsola and Adegoke, 1981). The area is governed by two major climatic seasons, which are the dry season stretching from November to March and the rainy (or wet) season which occurs between April and October. Occasional rainfalls usually occur within the dry season, particularly along the region adjoining the coast. Mean annual rainfall is greater than 2000 mm and constitutes the primary origin of groundwater recharge and replenishment in the area.

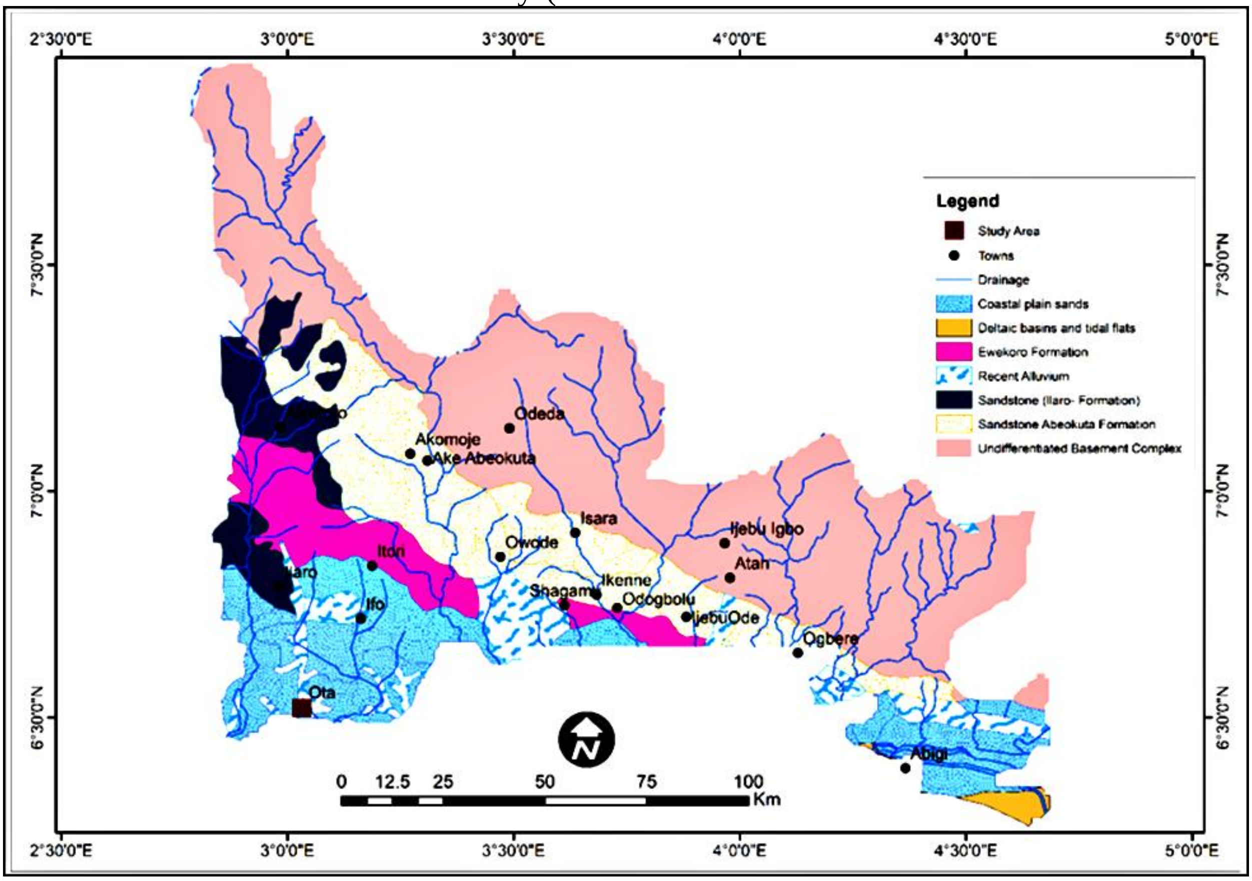

Fig. 1: Geological map of Ogun State showing the study location which falls within the Recent Alluvium environment in the sedimentary region.

2.0 Materials and Methods

2.1 Data acquisition

Data acquisition traverses were set up parallel to the failed road stretch to achieve the goals of investigating the subsurface conditions at road segments that have experienced perennial collapse (Fig. 2). A total of 40 VES stations and 12 ERT traverses were occupied for sufficient coverage of the study location. PASI 16GL Terrameter and its accessories were deployed for resistivity data collection, while Garmin 12 global positioning system (GPS) was used for obtaining the geodetic coordinates of locations. Before starting the measurements, the recording equipment was examined to make sure the electrodes were securely connected to the soil and that the electrode spacing was appropriate for the types of electrode arrays. The Wenner electrode array was used for the 2D electrical resistivity imaging (ERI) measurements. For this configuration, four electrodes, denoted as A, M, N, and B, are placed in line and spaced equidistant from each other. The two outer electrodes, A and B, are the current electrodes, and the two inner electrodes, M and N, are the potential electrodes. The detection of lateral resistivity changes is accomplished by moving the four electrodes across the surface while maintaining constant electrode separation (Telford et al., 1990; Keary et al., 2002). The Wenner electrode configuration is well suited for constant separation data acquisition so that many data points can be recorded simultaneously for every current injection (Griffiths, and Barker, 1993; Keller and Frischknecht, 1996; Dahlin and Loke, 1998; Loke et al., 2013). In addition, it has been well utilized in geotechnical investigations to detect variations in bedrock depth and the presence of steep discontinuities (Vivaldi et al., 2024). Measurements at each traverse covering a maximum distance of 100 m, were made for sequences of electrode spacing at 5, 10, 15, 20, 25 and 30 m intervals based on the availability of space and the desired depth of penetration. The VES stations were occupied at different points using the Schlumberger electrode configuration with the maximum current electrode separation (AB/2) of 130 m such that the near-surface targets (i.e. soft soils) are penetrated and successfully delineated. On each 2D electrical imaging profile, three to four VES points were carried out to integrate the VES with the ERI data. The VES technique is a very versatile resistivity technique which offers speed and accuracy and can be used in a wide range of geologic settings. VES measurements are typically made quickly, allowing for rapid data acquisition and inversion (Bhattacharya and Patra, 1968; Gupta et al., 1997; Atzemoglou and Tsourlos, 2012; Bouchaoui et al., 2022).

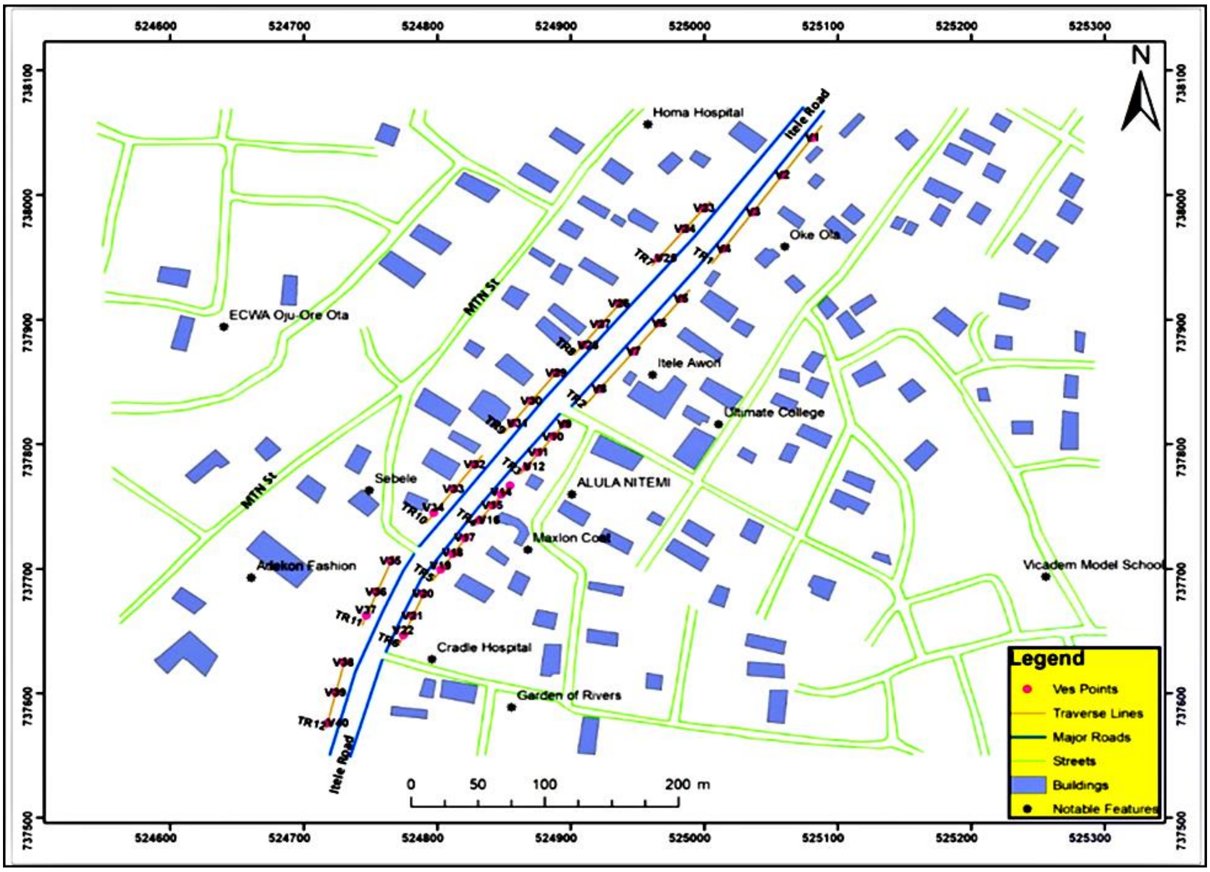

Fig. 2: Data acquisition map of the study showing the layout of survey stations and traverses. The red dots are the VES points, the brown lines are the traverse lines.

2.2 Data processing and interpretation

1D inversion of each VES data, together with borehole information, was used for the construction of eight geoelectrical sections which exhibit the main geoelectrical characteristics of the geological units present in the area. The apparent resistivity data obtained were refined through quantitative and qualitative approaches. The quantitative treatment of resistivity sounding curves was performed using the partial curve matching procedure by plotting apparent resistivity values against current electrode separation on transparent paper (Agidike *et* al., 2024;Bhattacharya and Patra, 1968**)**. The partial curve matching technique involved the use of a standard two (2) layer master curves and four (4) auxiliary type curves (H, K, A, and Q). This methodology entails a section-by-section curve matching usually initiated at regions with shorter electrode separation and then shifted towards regions with longer spacing. The results of the VES partial curve matching were then used to constrain the interpretation through fast computer iteration with the aid of WinResist Software version 1.0 Vander–Velpen, 2004). WinResist software uses a least square inversion algorithm to interpret 1D electrical resistivity data. The algorithm has a maximum capacity of 30 iterations. This helped to reduce errors in the estimation of depths obtained from curve matching (Raj et al., 2014). The computer iteration generates the final resistivity, thickness and depth of the subsurface layers. The qualitative interpretation of the depth-sounding curves was carried out based on individual geoelectrical characteristics in combination with the number of layers represented by some combinations of the four auxiliary curve types (i.e., A, H, K, and Q). Forward modelling was also used to calculate the apparent resistivity values of 2-D resistivity data using Dipro software. This program operates mathematically based on the smoothness-constrained least squares method. The Dipro program amortizes the bulk data into a series of horizontal and vertical rectangular blocks, with each box containing several records. The resistivities of each block are then calculated to produce an apparent resistivity pseudo section. The preliminary map generated was matched with the field measurements for consistency or else the forward model is assumed to be inaccurate, and the model is rejected. Forward modelling simulates the electrical resistivity response of subsurface strata based on presumed geoelectrical models, facilitating the validation and enhancement of interpretations obtained from field data. The smoothness-constrained least squares method is particularly effective for modelling resistivity data in this context, as it guarantees a stable and reliable inversion by minimizing abrupt resistivity changes, which corresponds with the inherent subsurface variability of soft soil layers like peat and clay (Ojo *et al*., 2023). This method adeptly reconciles model resolution and smoothness, facilitating the precise delineation of geoelectrical profiles (Loke and Barker, 1996).

3.0 Results and Discussion

VES analysis provides a quantitative interpretation and description of the geoelectric layer sequence in terms of the potential number of layers, their corresponding resistivities, and their thicknesses/depths. Conversely, ERI is qualitative and is employed to produce a picture of a particular area of the Earth's subsurface. Nonetheless, ERI can still produce valuable outcomes that supplement the data gathered using the VES technique (Loke, 2000). The results of this study and the main interpreted features are presented as resistivity-sounding curves (Fig. 3), table, geoelectric sections (Figs. 4 – 9) and 2D images (Figs. 10 – 15). Geoelectric sections are generated from the summary of VES results by using AutoCAD software to draw -pseudo-2D sections of adjacent sounding stations along each survey line. This involved the combination of two or more interpreted VES results along any profile; traverse 1 (VES 1-4), traverse 2 (VES 5-8), traverse 3 (VES 9-12), traverse 4 (VES 13-16), traverse 5 (VES 17-19), traverse 6 (VES 20-22), traverse 7 (VES 23-25), traverse 8 (VES 26-28), traverse 9 (VES 29-31), traverse 10 (VES 32-34), traverse 11 (VES 35-37) and traverse 12 (VES 38-40). Results of 2D imaging techniques configured as 2D resistivity structures. The sounding curves obtained generally show a simple subsurface sequence where low resistivity layers are sandwiched between moderate resistivity layers. Table 1 shows that soft soil (peat and clay) was encountered at shallow depths of 0.5-1.0 m at some locations and a moderate depth range of 3.1-10.5 m.

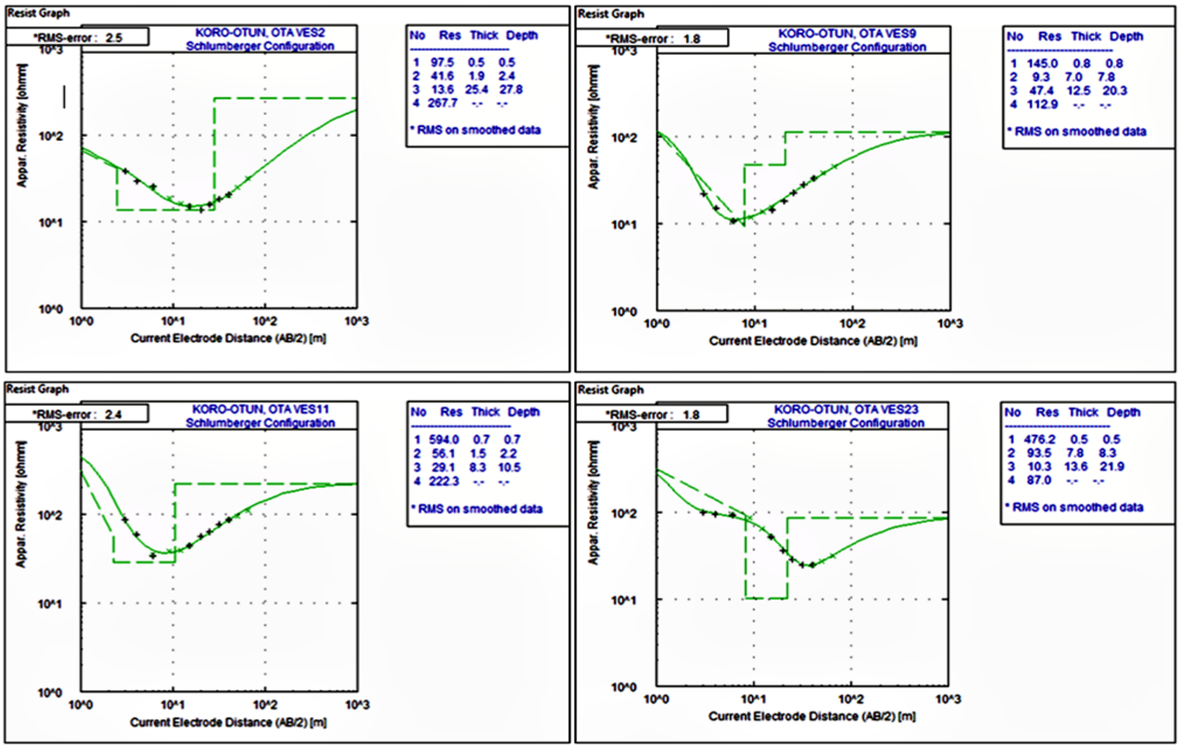

Fig. 3: Samples of VES curves obtained after computer iterations of field data with the input of initial curve models obtained from manual curve matching technique. Cup-shaped resistivity curves typical of low resistivity layer sandwich between moderate/high resistivity zones.

Table 1: Summary of VES results showing total subsurface thickness probed, soft soil thickness and depth. Thickness is indeterminable at locations where clay/peat zones were delineated as the last layer.

VES	Total subsurface thickness	Thickness of soft soil medium	Depth to soft soil medium
1	18.0	5.5	0.7
2	27.8	27.3	0.5
3	17.0	16.2	0.8
4	24.7	3.3	0.9
5	20.2	-	-
6	11.2	-	-
7	10.1	-	-
8	19.2	1.2	3.6
9	20.3	19.5	0.8
10	28.4	27.4	0.7
11	10.5	8.3	10.5
12	16.3	13.2	3.1
13	16.8	-	-

14	8.9	-	-
15	15.3	-	-
16	24.4	-	-
17	24.7	17.8	6.9
18	14.1	8.8	5.3
19	14.8	9.6	5.2
20	30.3	25.1	5.1
21	6.8	-	6.8
22	6.1	-	6.1
23	21.9	13.6	8.3
24	39.2	34.8	4.4
25	38.5	31.9	6.6
26	27.1	7.8	0.8
27	20.2	7.7	0.6
28	17.9	3.2	0.5
29	18.6	-	-
30	23.0	8.0	0.7
31	22.7	3.1	1.0
32	5.8	-	5.8
33	6.9	-	6.9
34	6.5	-	-
35	9.0	-	-
36	6.7	-	6.7
37	9.7	-	-
38	21.4	14.9	6.5
39	27.4	20.1	7.3
40	7.3	-	-

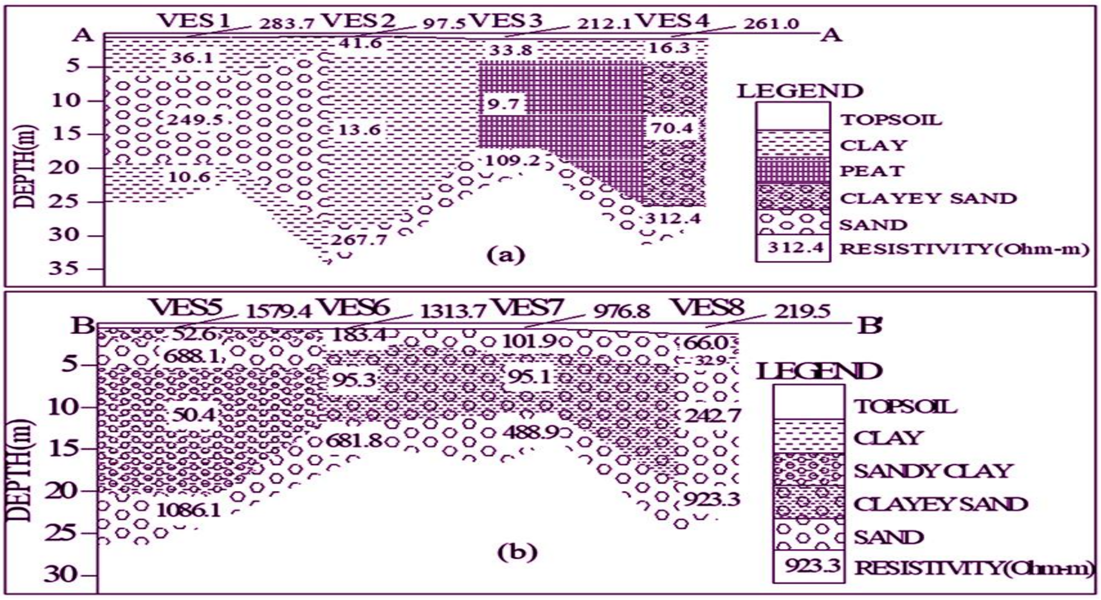

Fig. 4: Geoelectric sections beneath traverses AA' and BB'. Low depth (shallow) clay and confined peat strata delineated across the entire traverse AA' at different depths. Absence of peat/clay subsurface along traverse BB'

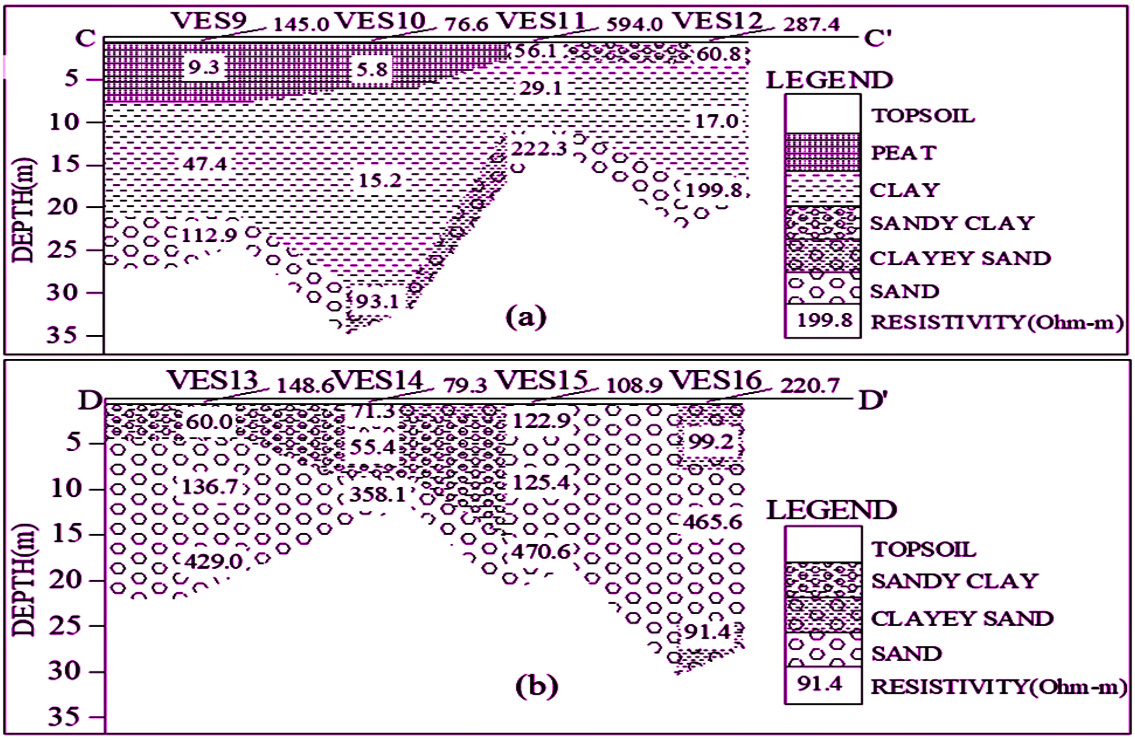

Fig. 5: Geoelectric sections beneath traverses CC' and DD'. Unconfined peat strata/zones delineated directly beneath the topsoil layer along VES 9 and 10 and directly above clay medium along traverse CC'. Peat/clay subsurface layers absent across traverse DD'.

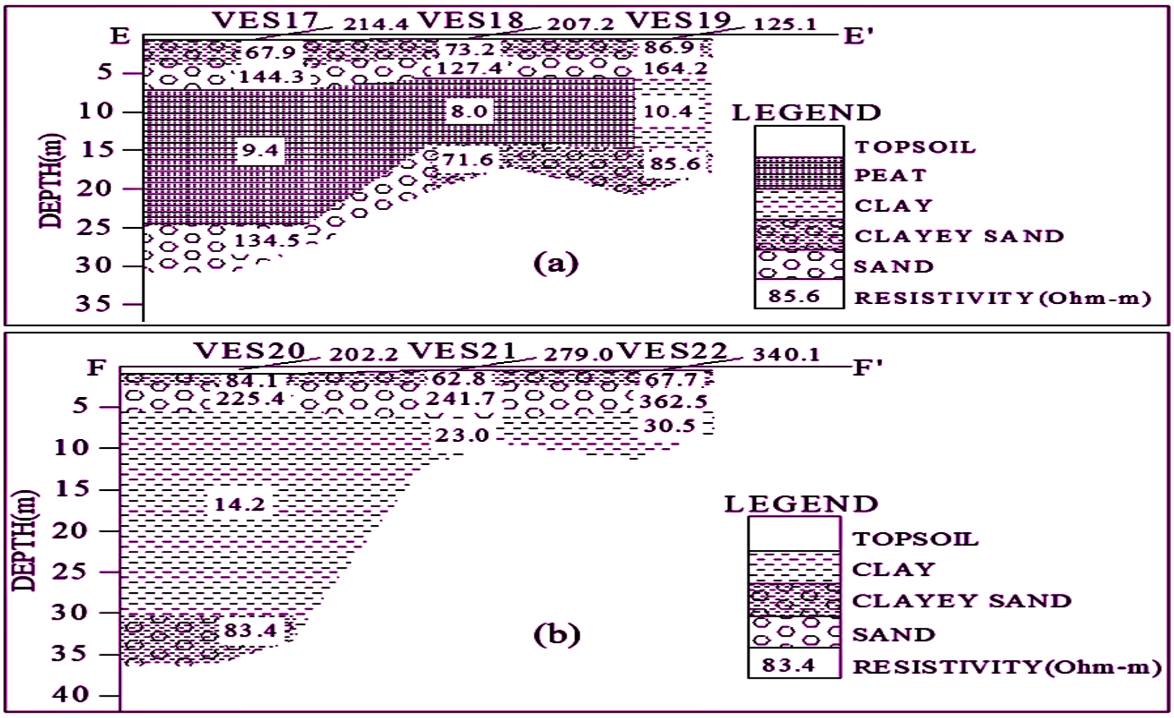

Fig. 6: Geoelectric sections beneath traverses EE' and FF'. Peat strata delineated at a depth beyond 5 m beneath VES 17 and 18. Traverse FF' entirely underlain clay at varying thicknesses and depths.

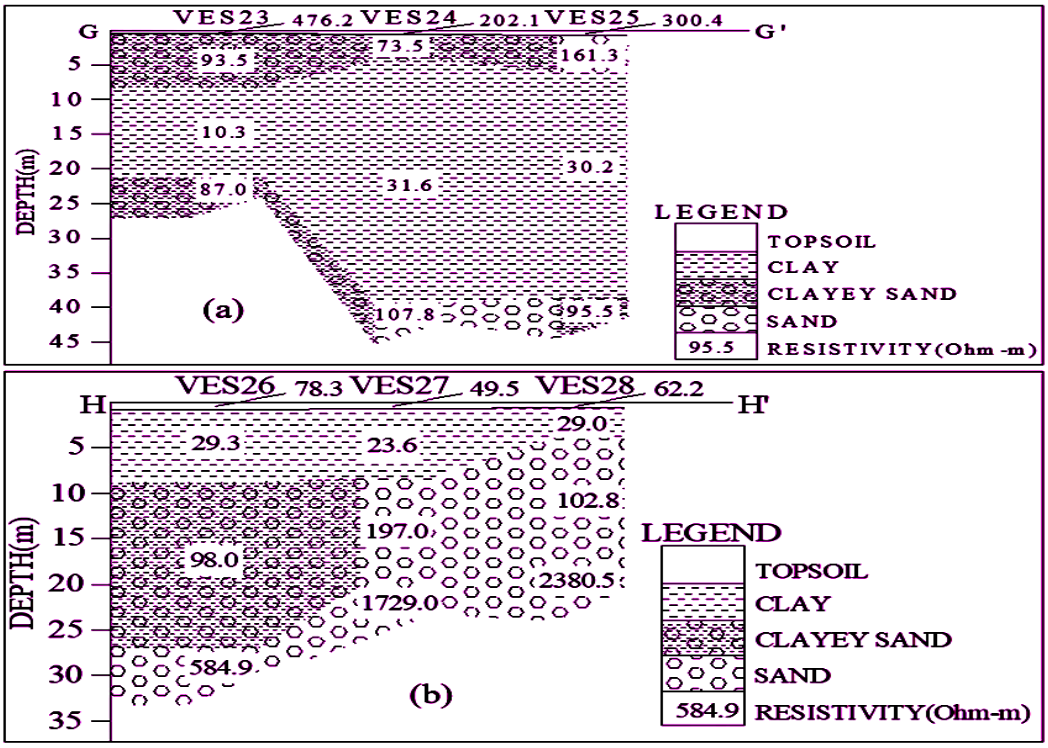

Fig. 7: Geoelectric sections beneath traverses GG' and HH'. Clay zone of considerable thickness underlies the topsoil and clayey sand layers along GG'. Low thickness clay medium delineated across HH'.

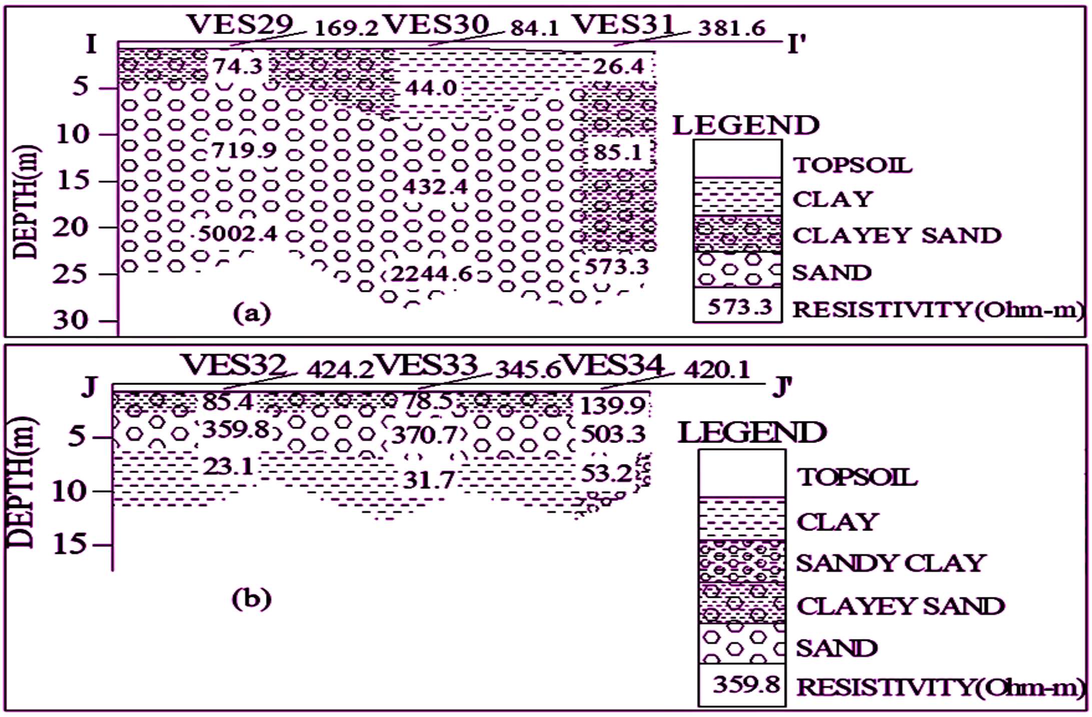

Fig. 8: Geoelectric sections beneath traverses II' and JJ'. Expansible and compressible clay zones of finite volume directly beneath the topsoil layer along II' and as the last layer where the current is terminated along JJ'.

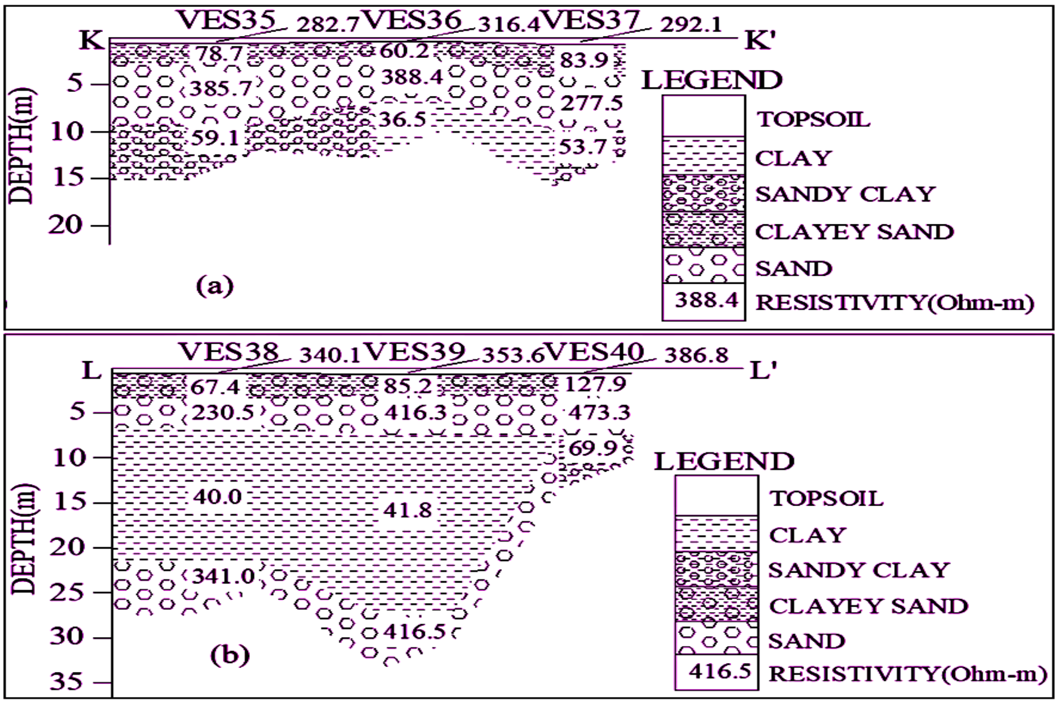

Fig. 9: Geoelectric sections beneath traverses KK' and LL'. The clay subsurface layer was delineated only at VES37 along KK'. Moderately thick bowl-shaped clay zone along LL'.

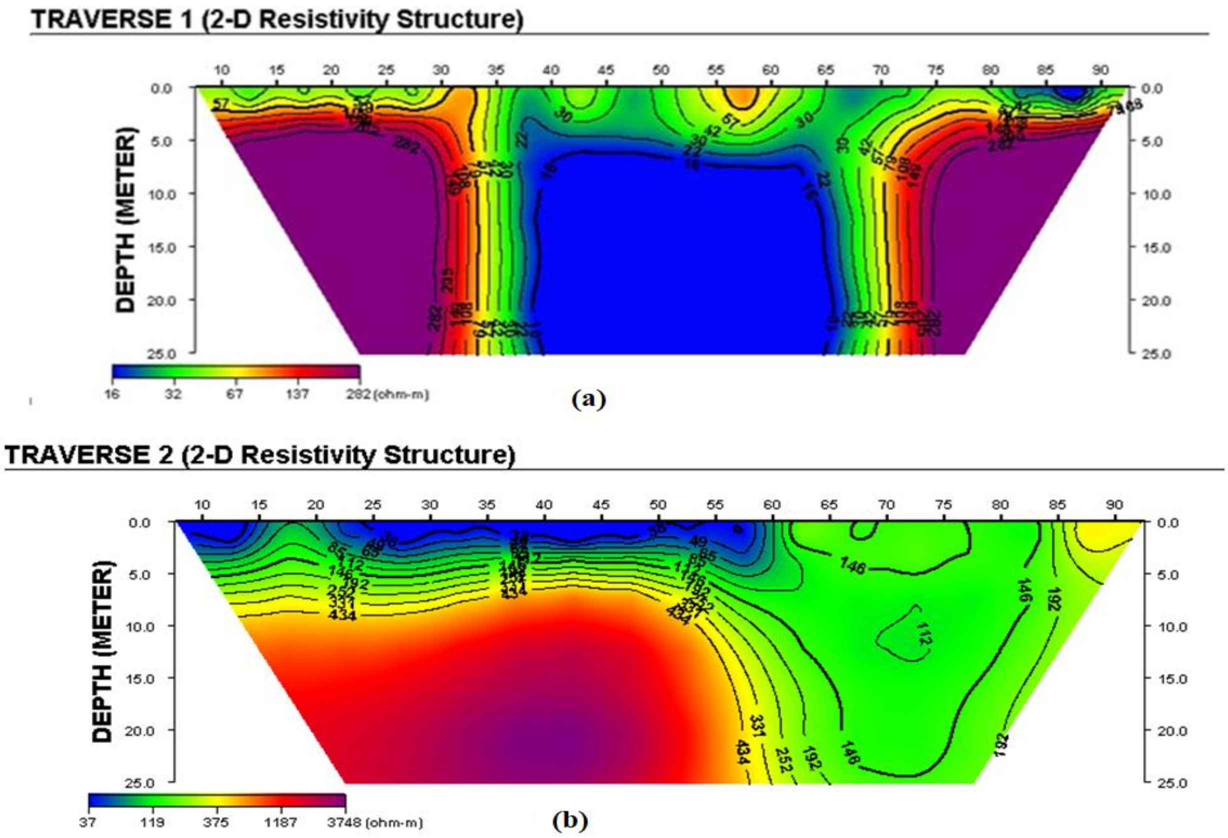

Fig. 10: Low resistivity topographic ridge/mound of moderate thickness imaged at the middle of traverse 1. In contrast, a thin layer of similar resistivity layer commixes with topsoil at shallow depth along traverse 2.

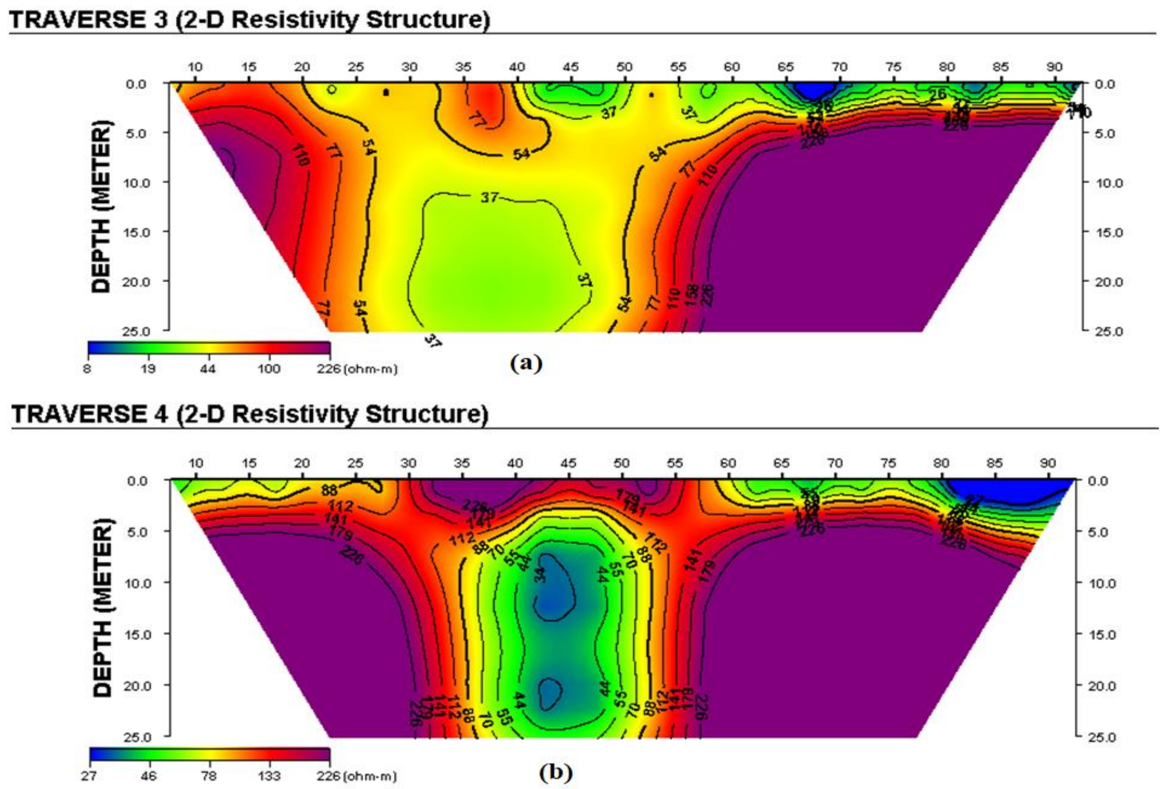

Fig. 11: Low resistivity ridge/mound depicted below 2 m depth at the top of the two traverses are presumably lateritic soil mixed with topsoil materials.

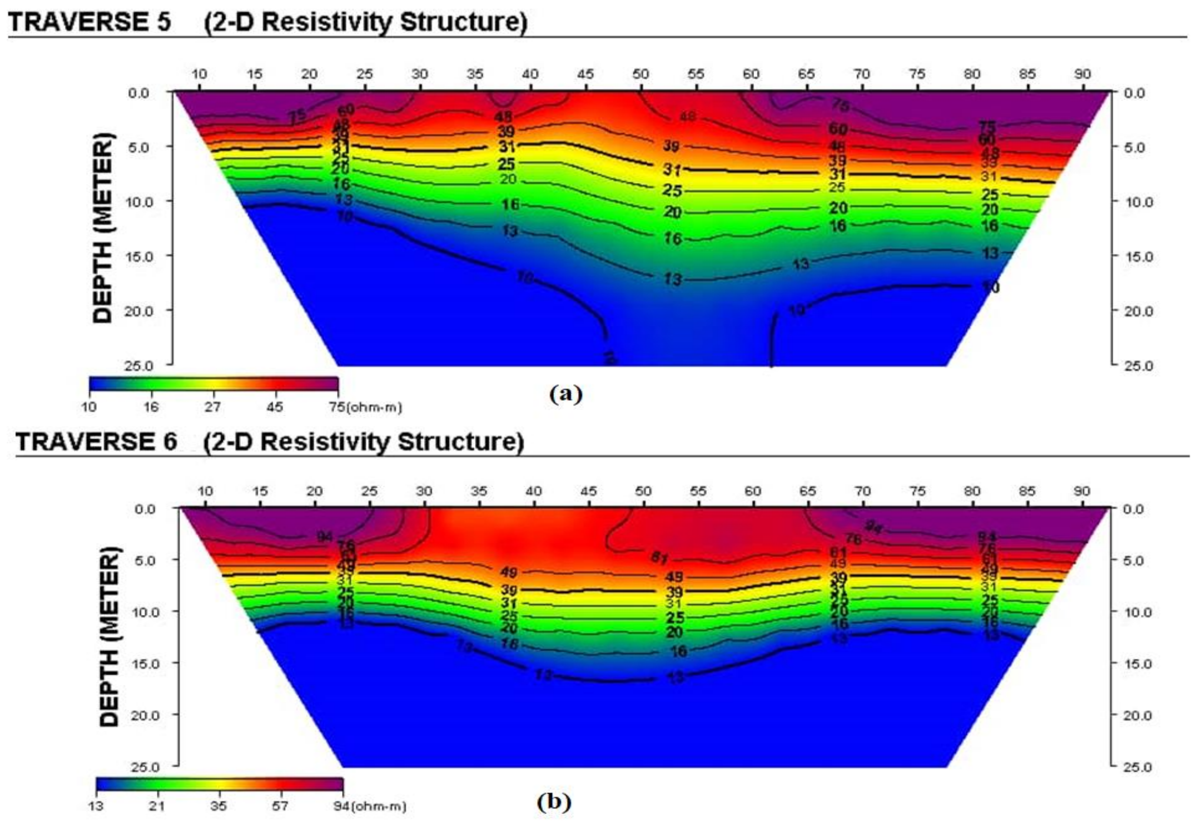

Fig. 12: Traverses 5 and 6 share similar subsurface geologic features in the form of stratified low resistivity zones as the lowermost regions of undefined thickness and depth.

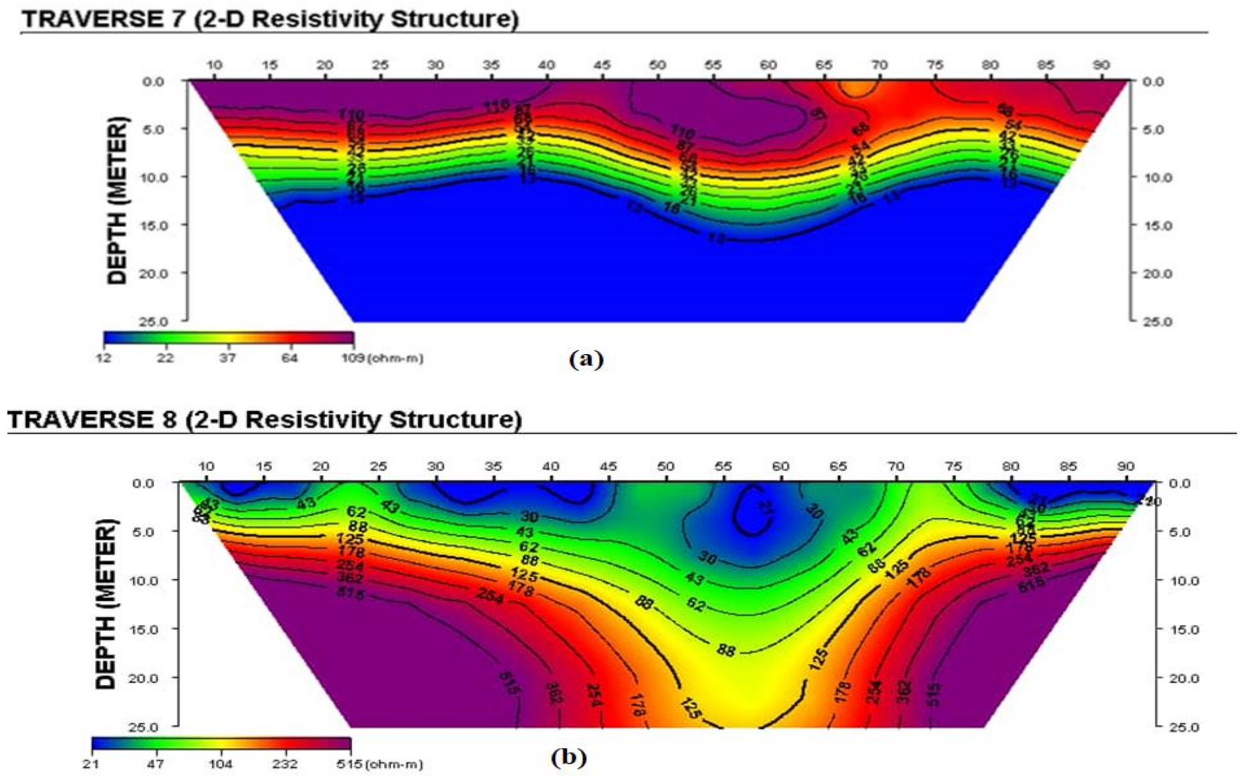

Fig. 13: Traverses 7 of comparable stratigraphic features with traverse 5 and 6 indicating low resistivity zones. Uppermost region of traverse 8 is presumably lateritic soil with debris.

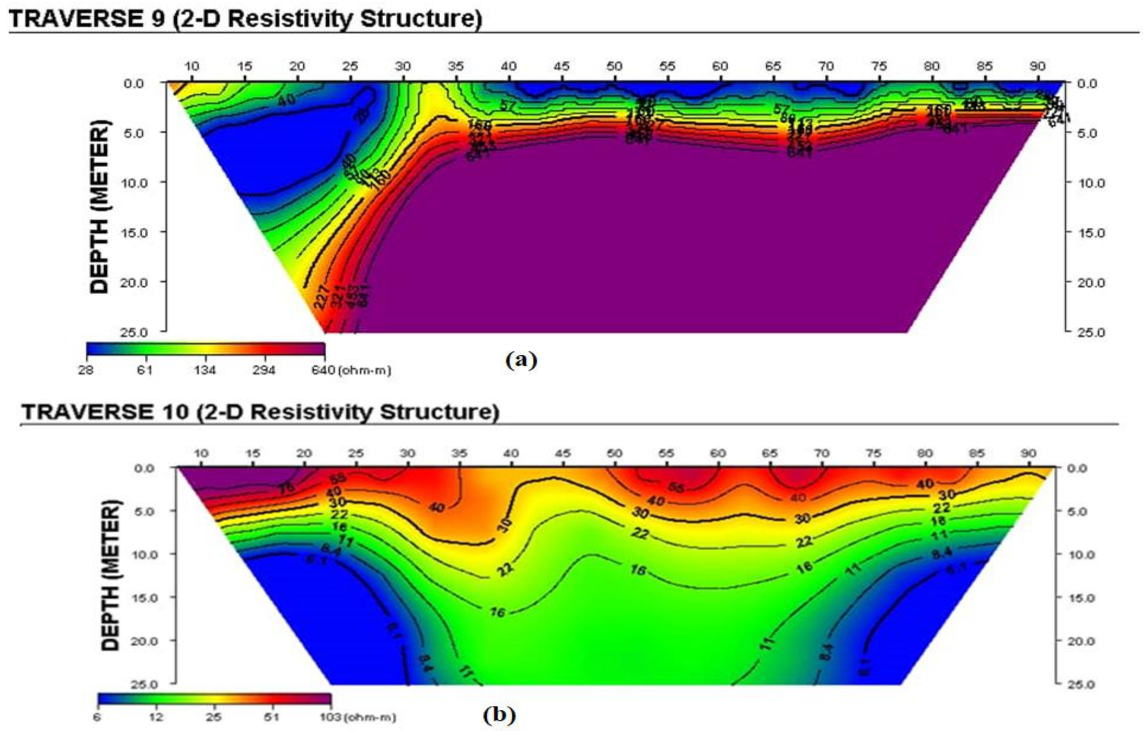

Fig. 14: Fringes and topmost of very low resistivity zones probably composed of laterite with topsoil at traverse 9. Low resistivity (< 10 Ωm) at a depth of about 9 m downward delineated as peat at the extremes and a trough of clay (resistivity < 30 Ωm) at the middle of traverse 10.

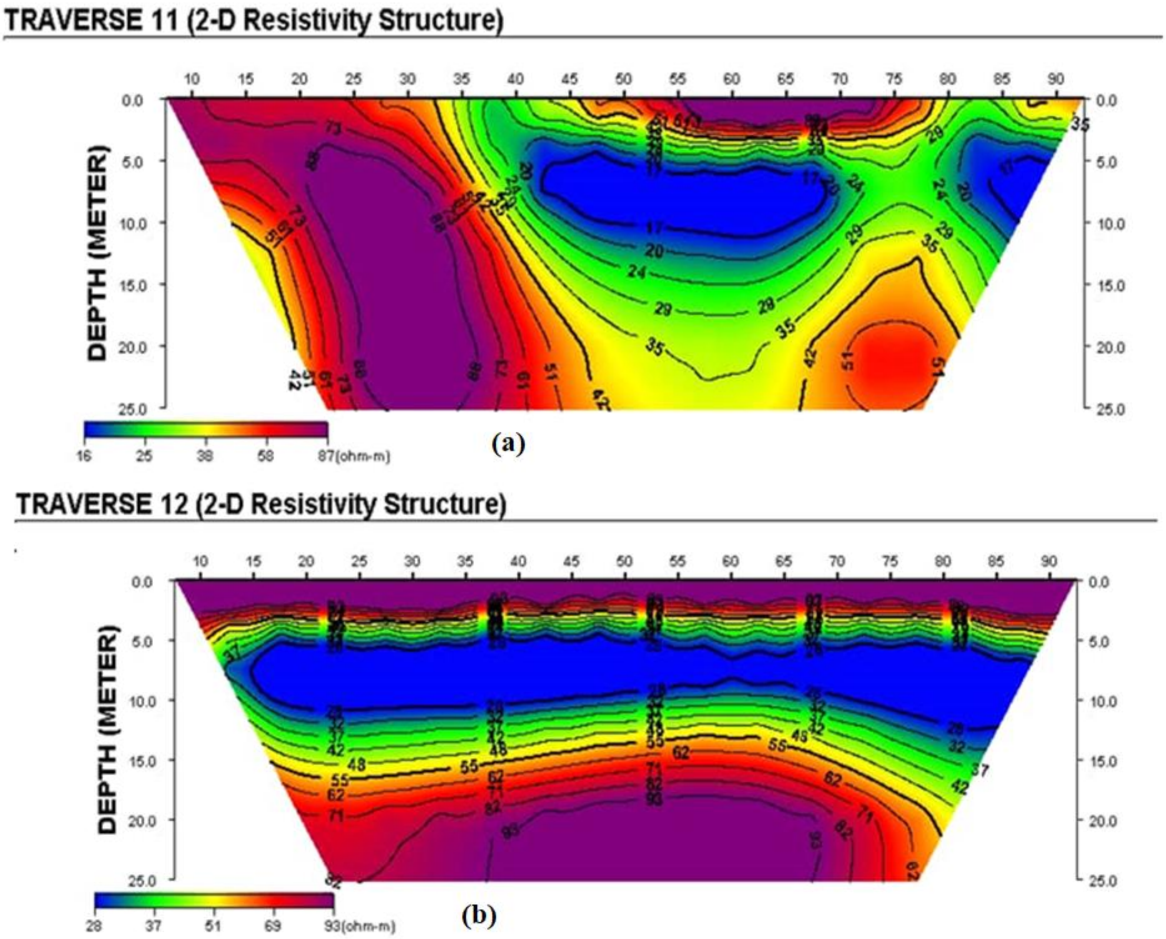

Fig. 15: Low resistivity clay bed and depression sandwiched within moderate resistivity regions are recognizable at the center of traverse 11 and as near horizontally stratified zone across traverse 12.

The combination of VES and 2D resistivity imaging techniques has provided valuable geophysical data on the stratigraphy and structure of soft soil (peat and clay) zones at the study location. The delineated subsurface conditions are very significant and relevant to road pavement stability at Koro Otun in Ota, near Idiroko in Ogun State, Nigeria. A maximum of five geoelectric layers (topsoil, clay, peat, sandy clay/clayey sand, sand) were delineated from the results of both VES and 2D resistivity imaging techniques at a maximum depth of about 39.2 m across stations. The topsoil layer, usually affected by anthropogenic activities and events is presumably an admixture of lateritic soil and refuse/waste materials and is generally very thin at depths less than 1 m in virtually all surveyed locations. Soft and collapsible low-bearing capacity soils of varying thicknesses are encountered in many of the locations surveyed at different depths. This suggests the need for proper foundation consideration to mitigate against the recurrence of road failure in the study area. In addition, the differing lithological sequence below and above the peat/clay layer across the study site implies the need for a point-by-point and detailed approach to the future implementation of geotechnical and construction works. The peat/clay layer is relatively well defined from the VES analysis and interpretation. Peat material (resistivity 8.8 – 9.7 Ωm and thickness 6.2 – 17.8 m) was delineated along 3 traverses with 6 locations (15 %) at shallow depth of 7.8 – 24.7 m; clay (resistivity 10.3 – 47.4 Ωm and thickness 1.9 – 34.8 m) has more occurrences at 9 traverses consisting of 21 sounding stations (53 %) at varying depths 2.4 – 39.2 m), while 11 stations show no occurrence of either peat or clay subsoil. However, there are locations underlain by more competent subsurface materials such as sand/clayey sand and very few locations underlain by less competent sandy clay. Deep-lying clay subsurface layers at depths greater than 20 m but less than 40 m were delineated at a few locations. Both peat and clay occurred mostly in the second and third subsurface layers, except at 5 sounding stations where the current was terminated within the clay zone as the last layer.

ERI profiles indicate extended but discontinuous lateral distribution of clay and pockets of peat at a few locations. They also show that some cross sections such as traverses 5, 6, 7 (with soft soil at the base), 9 (sand as a lowermost layer) and 12 (trapped soft soil in the middle) are horizontally stratified indicating possible stable sedimentary depositional environment (El-Qady et al., 2005). Other stratigraphic features recognized are subsurface ridges/mounds at traverses 1, 4, and 11 all constituting soft soil deposits and trough/depressions at traverses 3 (of soft soil zone), 8, 10 and 11. If appropriate geophysical and engineering considerations are made during project execution, the durability and lifespan of roads in the Ota and Idiroko communities could still be reasonably extended despite the daily presence of a high volume of vehicular traffic, primarily from heavy-duty trucks. For determining the stratigraphy and structure of soft soil (peat and clay) in the study location, the combination of VES and ERI is a very useful geophysical technique that has unearthed hidden zones of peat and clay. Hence, the findings and interpretation offered would be beneficial to geotechnical and construction professionals in tackling the perennial problem of pavement collapse.

4.0 Conclusion

The electrical resistivity survey method via VES and ERI techniques has been utilized to delineate the occurrence of soft soil (peat and clay) zones along some dilapidated portions of the Koro Otun/Itele Ayetoro Road within the Koro Otun community, close to Idiroko-Ota express road. Several roads in the study location serve as alternate routes to this popular international highway, which is a gateway from the Benin Republic to Nigeria. Interpreted results from the two techniques reveal five distinct geoelectric strata. The maximum depth penetrated by current injection was 32.9 m across the surveyed stations. The resistivities of peat and clay were found to be less than 10 Ωm and 50 Ωm respectively. Very low resistivity (ρ < 10 Ωm) peat material was delineated beneath 6 traverses (15 %), while low resistivity clay (10 Ωm < ρ < 50 Ωm) has more occurrences at 9 traverses (53 %). 11 other stations show no occurrence of either peat or clay subsoil. Few locations with more competent subsurface media (sand and clayey sand) are underlain by less competent sandy clay. Both peat and clay occurred mostly in the second and third subsurface layers, except at 5 sounding stations where clay is the last layer where the current was terminated. ERI reveals extended but discontinuous clay zones and pockets of peat at a few locations. Some cross sections show horizontally stratified soft soil at the base, with sand as the lowermost layer. While other subsurface stratigraphic features such as ridges/mounds, trough/depressions and horizontally stratified columns and trapped beds are identifiable at several traverses. Since the construction of roads and other engineering structures in soft soil environment is a recognized challenge in the field of geotechnical engineering, there is a need for appropriate subsurface geophysical investigation and evaluation as preliminary procedures before main construction works. This will assist in preventing the emergence of engineering problems (such as slope instability, bearing capacity failure or excessive settlement) which often arise due to low shear strength and high compressibility of this category of problematic soil.

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Authors; Contribution

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