Nigerian Research Journal of Engineering and Environmental Sciences 4(1) 2019 pp. 376-382

Nigerian Research Journal of Engineering and Environmental Sciences
Journal homepage: www.rjees.com

Original Research Article

Two Dimensional Geoelectrical Resistivity Investigation of University of Benin Golf Course at Ugbowo in Benin City, Edo State, Nigeria using Wenner Alpha and Wenner Schlumberger Configuration

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ARTICLE INFORMATION

Article history:
Received 29 January, 2019
Revised 13 April, 2019
Accepted 28 April, 2019
Available online 30 June, 2019

Keywords:
Geoelectrical
Tomography
Array
Two-dimensional
Subsurface

ABSTRACT

The purpose of this study was to determine the subsurface resistivity distribution from a 2-D imaging survey and determine the tomography /images of University of Benin Golf course, Benin City, Edo State Nigeria by comparing two arrays. Wenner Schlumberger and Wenner Alpha configuration profiling methods were used to elucidate the lateral changes in the subsurface resistivity. From these measurements, the true resistivity of the subsurface was determined by inversion of the measured apparent resistivity values using computer inversion software (RES2DINV). From the images obtained, it was clearly observed that, different configurations used to map the same region can give different contour shapes. The Wenner Alpha configuration has relatively poor horizontal resolution as the electrode spacing is increased by virtue of its small geometric factor, while the Wenner Schlumberger configuration shows high resistivity values as a result of its high geometric factor which is observed as the electrode spacing increases.

1. INTRODUCTION

The knowledge of the subsurface geology and the characterization of the spatial distribution of subsurface physical properties are necessary for effective environmental monitoring, protection and remediation in polluted areas, as well as for infrastructure development purposes (Ahzegbobor, 2011). This will assist policy makers and environmental managers to make quality decisions required to preserve and sustain a healthy environment for mankind and the ecosystems in general, and to effectively and safely manage our natural resources (Ahzegbobor, 2011).

The choice of a particular geophysical method depends mainly on the objective of the investigation relative to the sensitivity of the method, the resolution desired, the site conditions, time required for the survey, and

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the funds and computational resources available (Loke, 2004). Different geophysical techniques as well as available hydrogeological and geological data are often integrated to obtain a better understanding of the subsurface media at different scales and resolutions (Meju, 2000; Pedersen *et al.,* 2005). The study of weathering profile, its vertical variation, spatial distribution, textural characteristics of the constituent materials are essential step towards a better understanding of shallow site investigation in complex areas (Kaya and Fang, 1997). The heterogeneous nature of the subsurface, the geology of the subsurface needs to be investigated in considerable details to locate a successful site for construction (Kaya and Fang, 1997). This knowledge has led to the application of geophysical methods mostly electrical resistivity imaging in site investigation. Due to the limitations of the conventional resistivity sounding and profiling, such as shallow depth of investigation, nature of tomography of the survey area and the array use, electrical resistivity imaging (2D) was used (Loke, 2004).

The main aim of this study is to design 2D acquisition geometry in geoelectrical resistivity imaging by using Wenner array and Wenner Schlumberger methods to carry out inversion of the observed data set using a 2D model of interpretation without assuming subsurface homogeneity and from the delineated subsurface images and compare the best array and also determine the subsurface layers in the study area.

2. METHODOLOGY

2.1. Description of Study Area

This work was carried out at the University of Benin Golf course, Benin City, Edo State Nigeria (Figure 1). Geology of the study area is described in the geology of Niger delta. Edo State is an inland State in central southern Nigeria.

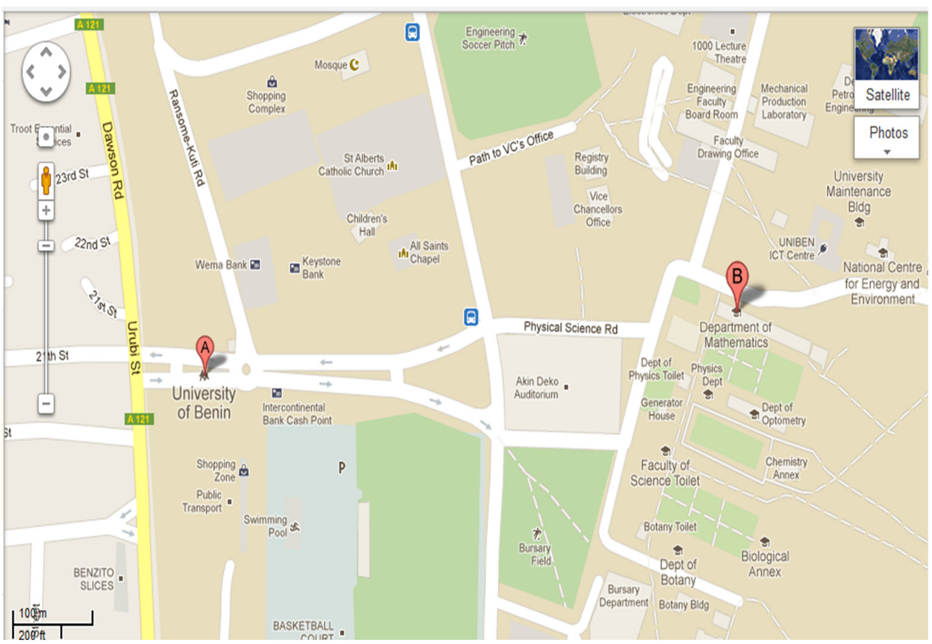

Figure 1: Map of the study area (Google Earth)

Its capital is Benin City. It was created from the defunct Bendel State on the 27th of August 1991 and is located in the rain forest belt of Nigeria between Longitude 5” 42’ and 6°45’E and Latitude 5” 45’N and 7” 35’N. It is bounded by Kogi State to north; to the east by both Kogi and Anambra States to the South by

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Delta State and by Ondo State to the west. It has a total land mass/area of 19,281.93 square kilometers ad eighteen (18) Local Government Areas that make up the three (3) senatorial districts, namely Edo South, Edo Central and Edo North. Natural resources abound in the State and these include hardwood and timber, limestone, marbles lignite crude oil, gold, clay, kaolin, granite, amongst others. The State is generally low-lying except in the northern part that is characterized by undulating hills.

2.2. Data Collection

2D electrical resistivity data was acquired in the field using the Wenner alpha and Wenner Schlumberger configuration with parallel lines of length 320 m. The apparent resistivity data computed from the parallel and orthogonal 2D sets were collated into 2D data sets. The collation of the 2D data set 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 was read by the RES2DINV program used for 2D data inversion and hence the subsurface images was determine. During the field survey, a minimum electrode separation of (10 meters) and inter-lines spacing 10 meters with a total length of 320 meters were used for both array system.

3. RESULTS AND DISCUSSION

Figures 2 – 5 show the 2D inverted images model from the survey with a total length of 320 m and electrode spacing of 10 m apart. Figure 2 and Figure 3 are the inverted 2D model obtained from the study area using the Wenner Alpha and Schlumberger configuration.

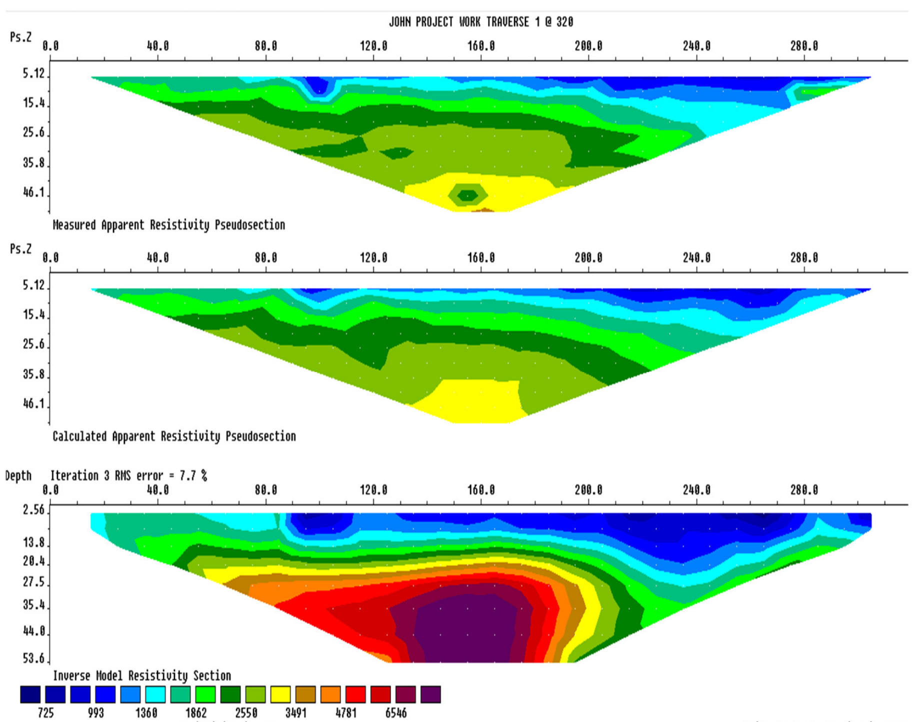

Figure 2: Two dimensional model obtained from the Wenner Alpha configuration for profile 1

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The subsurface images from the 2D model reveals that the Wenner Alpha configuration has the greatest signal to noise ratio with a clearer image as seen in Figures 2 and 3 because the profiles were taken in a noisy place (Loke, 2014). Figure 4 and Figure 5 are the inverted 2D model obtained from the study area using Wenner Schlumberger configuration. The images from the study area shows high resistivity values as seen in the resistivity keys at the bottom of each image displayed from Figures 2 – 5. The different colors show the various layers of the subsurface of the surveyed area and also indicate the soil compartment.

Figure 2 is the first profile and the image obtained from the Wenner Alpha configuration for the first profile with a depth of 53.4 m and a horizontal spread of 300 m. It can be seen from the image obtain using the Wenner Alpha configuration gives a clear image down to the depth of investigation. Loke (2014) also carried out a 2D investigation using the Wenner Alpha configuration and also obtained a clear image as the depth of investigation increases.

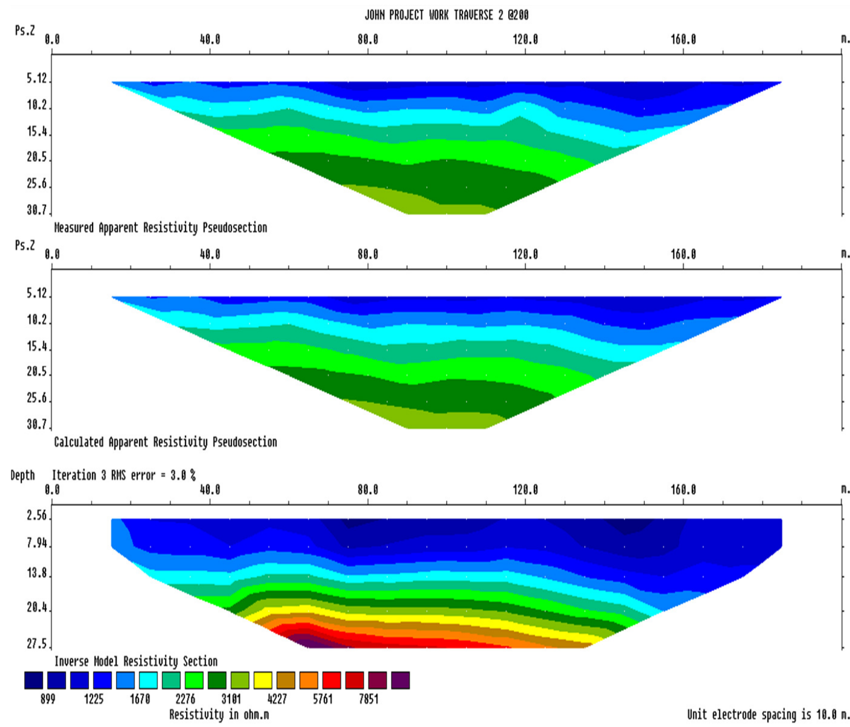

Figure 3: Two dimensional models obtained from the Wenner Alpha configuration for profile 2

Figure 3 is the second profile and the image obtained from the Wenner Alpha configuration for the second profile with a depth of 27.5 m and a horizontal spread of 200 m. It can be seen from the image obtained using the Wenner Alpha configuration gives a clear image down to the depth of investigation and also produce a clearer image between the boundaries of the various layers. This profile was taken in a noisy place where vehicular movement and human activities are intense, but yet the survey produce a clear image as a result of the use of Wenner Alpha configuration. Ahzegbobor (2011) showed that the use of Wenner Alpha configuration in 2D resistivity surveys in a nosily environment also produce clear images compare to other configurations.

Figure 4 is the third profile and the image obtained from the Wenner Schlumberger configuration for the third profile in the same place where profile 1 and 2 were taken with a depth of 54.5 m and a horizontal spread of 300 m. It can be seen from the image obtained using the Wenner Schlumberger configuration gives

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a clear image in terms of horizontal resolution even at wide electrode spreads down to the depth of investigation.

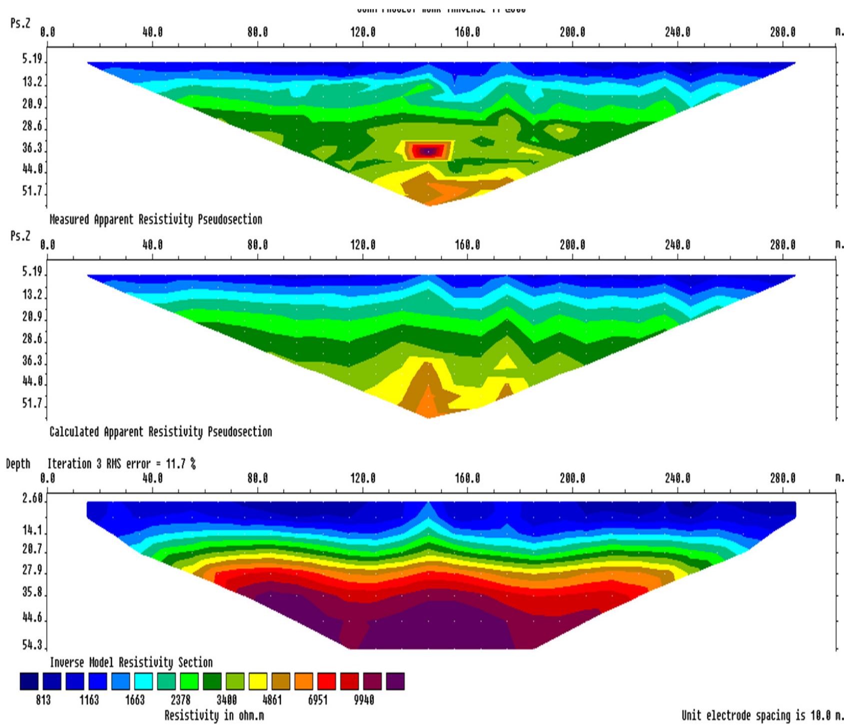

Figure 4: Two dimensional models obtained from the Wenner Schlumberger configuration for profile 3

Figure 5 is the fourth profile and the image obtained from the Wenner Schlumberger configuration for the fourth profile in the same place where profile 1, 2 and 3 were taken with a depth of 54.5 m and a horizontal spread of 300 m. It can be seen from the image obtained using the Wenner Schlumberger configuration gives a clear image in terms of horizontal resolution even at wide electrode spreads down to the depth of investigation. In the image obtained in Figure 5, it is seen that between the 5 m – 44 m depth, that there was good horizontal resolution between the boundaries of the image.

Different arrays used to map the same region can give rise to very different contour shapes. The Wenner Alpha array has relatively poor horizontal resolution as the electrode spacing is increased. By virtue of its smaller geometric factor, the Wenner Alpha array has the greatest signal to noise ratio. The Wenner Alpha array, though having a relatively poor resolution has the greater vertical resolution. It is also more sensitive to changes in resistivity while the Wenner-Schlumberger array shows high resistivity values as a result of its high geometric factor which is especially obvious as the electrode spacing increases. The Wenner-Schlumberger array has greater need for expertise. It is also more time-consuming during data acquisition. The Wenner-Schlumberger arrays should be used when the demand is for a good horizontal resolution even at wide electrode spreads (Loke, 2004). Both arrays can give very similar contour shapes if there are little changes in the subsurface resistivity.

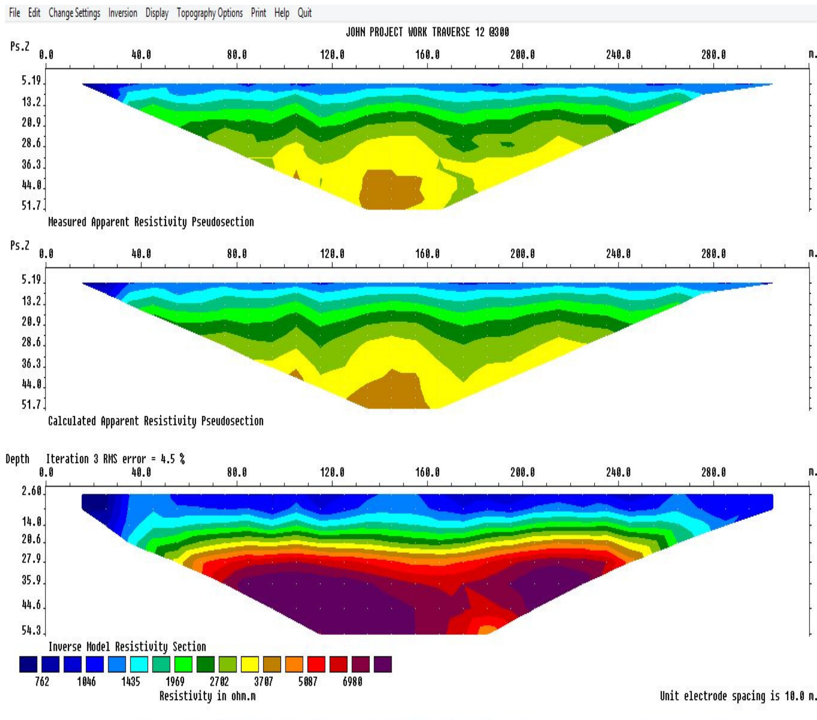

Figure 5: Two dimensional models obtained from the Wenner Schlumberger configuration for profile 4

4. CONCLUSION

The 2D geoelectrical resistivity survey in University of Benin golf course at Ugbowo in Benin City, Edo State has helped to delineate the subsurface images of the area and compare two different configurations. It is evident from the result of the modeled 2D images, that different configurations used to map the same region can give rise to very different contour shapes. The use of the Wenner-Schlumberger configuration is discouraged for surveys in noisy regions because of its high geometric factor while Wenner Alpha configuration is recommended in such cases. When there is a dearth of expertise, the Wenner Alpha is strongly recommended. The Wenner-Schlumberger should be used when there is demand for a good horizontal resolution even at wide electrode spreads.

5. ACKNOWLEDGEMENT

The authors appreciate God for knowledge and the University of Benin community for their support.

6. CONFLICT OF INTEREST

There is no conflict of interest associated with this work.

REFERENCES

Ahzegbobor, P.A. (2011). Acquisition geometry and inversion of 3D geoelectrical resistivity imaging data for environmental and engineering investigations. *Journal of Scientific research and essay,* 3(23) pp. 3592-3605

Asseez, L.O. (1972). Rural water supply in the basement complex of Western State, Nigeria. *Hydrogeological Sciences Bulletin*, 14, pp. 97-110.

Meju, M. A. (2000). Environmental geophysics tasks ahead. *Journal of Applied Geophysics*, 44, pp. 63-65.

Pedersen, L. B., Bastani, M. and Dynesius, L. (2005). Groundwater exploration using combined controlled-source and radiomagnetotelluric techniques. *Geophysics*, 70, pp. G8-G15.

Loke, M.H. (2014). Tutorial: 2D and 3D electrical imaging surveys. Available at *www.geotomosoft.com*.

Loke, M. H. (2004). Tutorial: 2-D and 3-D electrical imaging surveys, Geotomo Software, *viewed 17 July 2007, <www.geoelectrical.com>*.

Kaya, A. and Fang, H.Y. (1997). Identification of contamination soils by dielectric constant and electrical conductivity. *Journal of Environmental Engineering,* 123(2), pp. 169-177.