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Comparative Performance Evaluation of Imported and Locally Fabricated Electrical Resistivity Meters for Subsurface Investigations

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ABSTRACT

Comparative study on performance of an imported (Ohmega) resistivity meter (RMA) and a locally fabricated (PZ-02) resistivity meter (RMB) was carried out with a view to evaluate the data measurement accuracy and reliability. Four 2-D resistivity profiling and twelve vertical electrical soundings (VES) were acquired from two study sites within Elizade University campus. The dipole-dipole and VES datasets obtained were statistically analyzed. 2-D Subsurface modeling was carried out using Dipro inversion software; while VES data interpretation was done through manual partial curve matching and WinResist iteration for geoelectric models refinement. At Site 1, the dipole-dipole analysis statistically revealed divergent performance rating for both resistivity meters. The poor statistical agreement at Site 1 was attributed to extreme outlier readings at specific electrode positions. The 2-D resistivity structure obtained at Site 1 revealed that both resistivity images did not delineate similar subsurface structure, with significant variation in RMS error; RMA (0.0961) and RMB (0.3489). At Site 2, the dipole-dipole data analysis for both resistivity meters showed very close agreement, as confirmed by the statistical analysis results. The 2-D inversion RMS errors of 0.0615 (RMA) and 0.0990 (RMB) support that the performance of both resistivity meters closely agree at Site 2. Obtained H, HA, KH VES type curves distributed across six depth sounding curves; shows 50% agreement. The comparative assessment shows that the performance of locally fabricated resistivity meter (RMB) is within acceptable limit, when compared to that of the imported resistivity meter (RMA) in near subsurface geophysical investigation.

INTRODUCTION

One of the most versatile methods used in geophysics for investigating the earth subsurface is the electrical resistivity method. It entails transferring an electric current through current electrodes and measuring the voltage on potential electrodes. The electrical resistivity method is a method that is use to ascertain the mechanical and physical characteristics of soils and shallow-depth subsurface rocks (Ali and Alkhalidy, 2026). These investigations cut across engineering site characterization, environmental studies, agro-geophysics, hydro-geophysics, archeogeophysics, forensics geophysics, geological studies and mineral exploration (Telford *et al.*, 1990; Reynolds, 2011, Parsekian *et al.*, 2017). The versatility of the method is due to its relatively simple operational procedures and its ability to delineate subsurface lithological variations based on their electrical properties (Reynolds, 2011).

Resistivity meters are essential instruments in electrical prospecting. Over the years, imported resistivity meters (which are specifically built for temperate regions) have been commonly used for geophysical investigations in tropical region in Nigeria because of their high precision and reliability. However, the high cost of acquiring and maintaining these resistivity meters have made it difficult to afford, for training students in the universities, small geophysical firms, geophysical companies and researchers, especially in developing countries, such as Nigeria. One of the main reasons for developing geoelectric equipment is the high price of commercial devices currently available (Agung Pratama and Suharsono, 2025). These limitations have encouraged efforts towards local design and fabrication

of resistivity meters using locally sourced materials and components (Adegoke *et al.,* 2020; de la Vega *et al.,* 2021). These fabricated resistivity meters should be able to withstand tropical weather conditions and produce quality datasets comparable to the imported resistivity meters. In practice, there are concerns on the accuracy, reliability, data repeatability and validation of resistivity meters. These concerns range from influence of soil types or conditions, instrument calibration and electrode contact resistance. The consistencies of instrument behavior under a given field condition is of major interest in geophysical field data acquisition. However, there is a need to assess and evaluate the accuracy, interpretation reliability and field effectiveness of the locally fabricated resistivity meters when compared to the imported resistivity meters, under the same field operating conditions. Hence, this study focuses on performance comparative study between a locally fabricated resistivity meter and an imported resistivity meter. This study aims to evaluate and compare the measurement performance and subsurface interpretation reliability of imported and locally fabricated electrical resistivity meters under comparable field conditions

MATERIALS AND METHODS

Description of the Study Area

The study area Elizade University, is situated between 814100 – 815360 m Northing and 732200 – 733050 m Easting of the Universal Transverse Mercator coordinate system, Minna zone 31N. It is located in Ilara-Mokin, Ifedore Local Government Area of Ondo State, Southwestern Nigeria. The study area is characterized by rolling hills and a gently undulating to flat topography. Major and minor roads connect the area. The towns and villages around include Igbara-oke, Ijare, Isarun, Ipogun, Ikota and Ipinsa. The study area is located within the Crystalline Basement Complex terrain of Southwestern Nigeria. Rocks of Precambrian Basement Complex rocks classified by Rahaman (1988) generally underlie the area. The lithologic units identified in the area includes migmatite gnesis, quartzite, biotite granite, charnokite, and porphyritic granites. It includes variably migmatised biotite-horneblende-gneiss with intercalated amphibolite (Oladapo *et al.,* 2009), as shown in Figure 1.

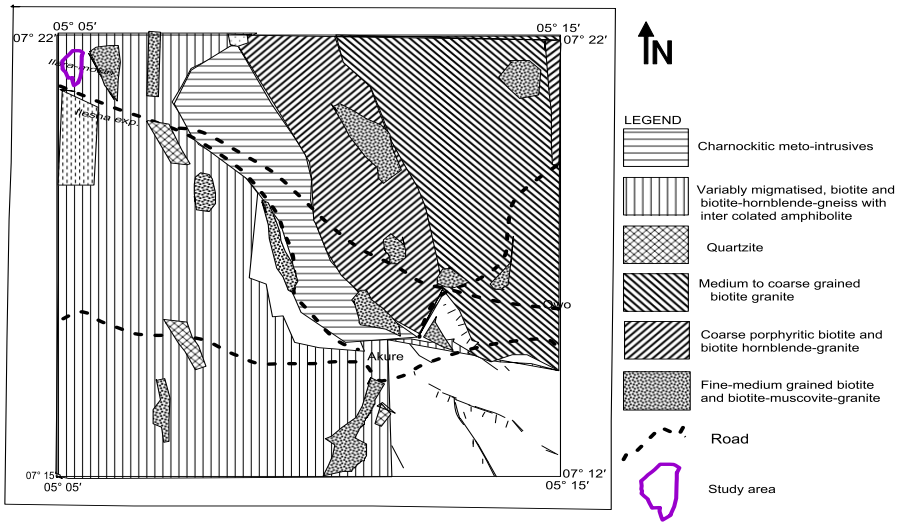


Figure 1: Geological map of the study area and its environs (modified after Oladapo *et al.,* 2009)

The primary materials used during this study are resistivity meters. Resistivity meter is used for measurement in electrical resistivity survey. It measures the electrical resistivity of the subsurface, which helps in identifying variations in rock and soil electrical properties. This instrument both injects current into the ground and measures the potential across the electrodes, recording the resultant apparent resistivity values. An imported (Ohmega) resistivity meter (RMA) and locally fabricated (PZ-02) resistivity meter (RMB) were deployed for this study (Figure 2). The calibration status of both resistivity meters is within acceptable range and up to date, and with similar technical specifications comprising of transmitter and receiver components. Other materials used includes; electrodes, cables reels, twine Reels, hammers, external battery, measuring tape, GPS (Global Positioning System), compass clinometer and field data sheets.



Figure 2: (RMA and RMB) Resistivity meters and accessories used for data acquisition

Electrical resistivity method adopted for this study was used to evaluate the performance between an imported (Ohmega) resistivity meter (RMA) and locally fabricated (PZ-02) resistivity meter (RMB). Two techniques were adopted for this study; the combined horizontal profiling/Vertical Electrical Sounding (VES), utilizing the dipole-dipole electrode configuration to measure apparent resistivity values laterally and vertically to produce 2-D resistivity subsurface images. VES have been meticulously utilized to probe the subsurface and to create subsurface geological maps (Ogholaja *et al.*, 2025). The VES technique was adopted by utilizing the Schlumberger and half Schlumberger electrode configurations, to measure the vertical variations in ground resistivity with respect to a fixed center of the array. Two sites were selected within the study area. At each selected site, a single dipole-dipole traverse with a total length of 100 m was established, along NW-SE orientation for Traverse 1 and Traverse 2. 2-D resistivity imaging survey was carried out using an electrode spacing of 5 m and expansion factor (n) that ranged from 1 to 4. Twelve VES were conducted across the two sites. The Schlumberger array was employed for the VES survey, with half-current electrodes spread length (AB/2) that varied between 1 and 65 m. The half Schlumberger array with half current electrode spread length (AB/2) that varied between 1 and 85 m was adopted on Site 2, due to space constraints. Firm soil-electrode contacts were ensured, but in cases of high electrode contact resistance; watering current electrode positions aided current injection. Measurements were taken simultaneously (i.e. along same line of electrodes set up) using both resistivity meters under the same field conditions at both sites. Field data were quality checked, through repeated measurements to ascertain reasonable level of consistency

RESULTS AND DISCUSSION

Statistical Analysis of Dipole-Dipole Resistivity Data and 2-D Dipole-Dipole Sections

The descriptive statistics of the apparent resistivity values recorded by both meters at each site using the Dipole-Dipole configuration was presented on Table 1. Sixty-six (66) paired measurements were acquired at each site. These statistical analyses were carried out using Microsoft Excel Software (Analysis ToolPak). At Site 1, RMA recorded a mean apparent resistivity of 196.06 Ωm compared to 231.58 Ωm for RMB, with a mean difference of -35.52 (Table 2). However, the standard deviation of RMA (62.41 Ωm) was considerably lower than that of RMB (214.43 Ωm), producing a coefficient of variation (CV) of 31.83% for RMA against 92.60% for RMB (Table 1). This disparity was caused by the extreme outlier readings recorded by RMB at three specific electrode positions, notably (1,173 Ωm, 1,352 Ωm and 910 Ωm) (Table 1). At Site 2, the descriptive statistics reveals a different trend. RMA recorded a mean of 116.89 Ωm and RMB recorded 116.74 Ωm, a difference of only 0.15 Ωm (Table 2). The standard deviations were 39.59 Ωm (RMA) and 50.36 Ωm (RMB), with CV values of 33.8% and 43.14% respectively (Table 1). The slightly higher CV for RMB at Site 2 is attributed to a single elevated reading of 378 Ωm recorded by RMB. Asides from this outlier, the two datasets at Site 2 are highly consistent, with marginally close means and medians, confirming strong overall measurement agreement between the meters under the same field conditions.

A paired t-test was carried out at a significance level of ($\alpha = 0.05$) to determine whether the difference between the two meters' readings at the same electrode positions was statistically significant. At Site 1, the t-statistic was -1.3223, yielding a p-value of 0.1907. Since $p = 0.1907 > 0.05$ and the t-statistic (-1.3223) at site 1 indicates that RMA recorded lower apparent resistivity values than RMB on average, a difference attributable to the extreme outlier readings that inflated RMB's mean, (Table 1). There is no statistically significant difference between the two meters at Site 1.

Table 1: Descriptive statistics of apparent resistivity values obtained at Site 1 and Site 2

Statistic	SITE 1 RMA- Imported	SITE 1 RMB- Fabricated	SITE 2 RMA- Imported	SITE 2 RMB- Fabricated
Count (n)	66.00	66.00	66.00	66.00
Mean (Ωm)	196.06	231.58	116.89	116.74
Std. Deviation (Ωm)	62.41	214.43	39.59	50.36
CV (%)	31.83	92.60	33.87	43.14

Table 2: Statistical analysis (Correlation analysis, paired t-test and error metrics)

Analysis	Site 1	Site 2
Mean Difference (RMA − RMB)	-35.52	0.15
Mean % Diff	41.93	10.1249
Pearson Correlation (r)	0.0845	0.8571
Coefficient Determination (R^2)	0.0071	0.7346
p-value	0.1907	0.9627
t-Statistic	-1.3223	-0.0470
RMSE	219.4401	25.9889
Mean Absolute Error- MAE (Ωm)	83.39	11.64

Table 3: RMS fitting error of 2-D Dipole-dipole inversion obtained from both Resistivity Meters at Site 1 and Site 2

RMS Fitting Error	0.0962	0.0962	0.0962	0.0962

The elevated standard deviation is because of the extreme RMB outliers reducing the test sensitivity (Table 1). The practical agreement between the resistivity meters at Site 1 was therefore poor, not because of a systematic meter difference but could be due to data quality at specific electrode positions. At Site 2, the t-statistic was 0.0047 with a p-value of 0.9627, far exceeding the 0.05 threshold, as presented on Table 2. This result strongly confirms no statistical significant difference between the meters at site 2. The mean difference of only 0.15 Ωm (Table 2) and the near-zero t-statistic indicates that the fabricated resistivity meter (RMB) produced readings equivalent to the imported resistivity meter (RMA) at Site 2, as corroborated with the correlation analysis obtained in Table 2. The Pearson correlation, r obtained at Site 1 ($r = 0.0845$) and Coefficient of Determination ($R^2 = 0.0071$), indicating no linear relationship between the two meters' readings, as presented in Table 2. As revealed, this is attributable to the extreme outlier values in RMB, which distorted its distribution while RMA remained comparatively stable (Figure 3). The likely cause of these outliers observed at Site 1 is due to poor electrode contacts possibly due to disturbed ground condition because of ongoing construction works. At Site 2, the Pearson correlation improved substantially to ($r = 0.8571$) and ($R^2 = 0.7346$), as presented in Table 2. This confirmed that both meters have closely related pattern of subsurface resistivity variation across the measurement profile. Approximately 73.5% ($R^2 = 0.7346$) of the variation of the subsurface delineated by RMA was also revealed by RMB (Figure 4). The single outlier observed at Site 2 by both resistivity meters, where RMA = 193 Ωm and RMB = 378 Ωm is likely attributable to electrode contact problem or a localised near-surface noise effect. Despite this, the overall Site 2 correlation remains strong ($r = 0.857$, $p = 0.963$), it confirmed that it represents isolated measurement event rather than a systematic behaviour of the fabricated meter. At Site 1, the Root Mean Square Error (RMSE) was 219.44 Ωm and Mean Absolute Error (MAE) was 89.39 Ωm, as shown in Table 2. Both heavily elevated by the outlier readings. The mean % difference was 41.93%, well above an acceptable 10% threshold. At Site 2, these metrics were considerably more favourable: RMSE = 25.99 Ωm, MAE = 11.64, while the mean % difference = 10.12%; slightly above the 10% threshold, possibly due to the single RMB outlier (378 Ωm). The RMS error obtained from 2-D model inversion at Site 1, RMA gave an RMS error of 0.0962. In contrast, RMB produced an RMS error of 0.3489, higher than RMA (Table 3). The higher RMS error therefore reflects the

same data quality issues identified in the statistical analysis, rather than a limitation of the fabricated resistivity meter's measurement capability. At Site 2, both resistivity meters achieved lower RMS errors. RMA and RMB produced 0.0615 and 0.099, respectively, this shows that the 2-D inversion model for both meters fitted the measured data well. The RMB RMS error of 0.0990 is slightly higher than RMA RMS error of 0.0615, reflecting the close agreement observed in the statistical analysis at site 2.

The Dipole-Dipole sections generated at Site 1 are presented in Figs. 5 and 6, oriented in the NW-SE direction. The field resistivity data were analyzed using the DIPRO software. There is a close correlation between the field data and the theoretical pseudo sections, which highlights acceptable level of correctness in the field data; thus corroborating the significantly low RMS error (0.0961) obtained for the 2-D resistivity structure image. The inverted images obtained from RMB (Figure. 6) at Site 1, showed minimal similarities with the image obtained for RMA (Figure 5). Some visible significant differences were observed between the field data and the theoretical data pseudo sections. The observed differences may have resulted in the appreciably high RMS error (0.3489) obtained for the 2-D resistivity structure. The output of the generated images from both resistivity meters (RMA and RMB) are significantly at variance both pictorially and statistically.

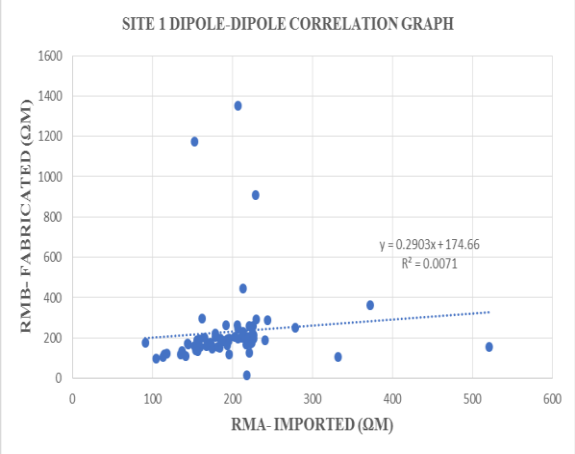


Figure 3: Correlation graph showing the relationship between RMA and RMB

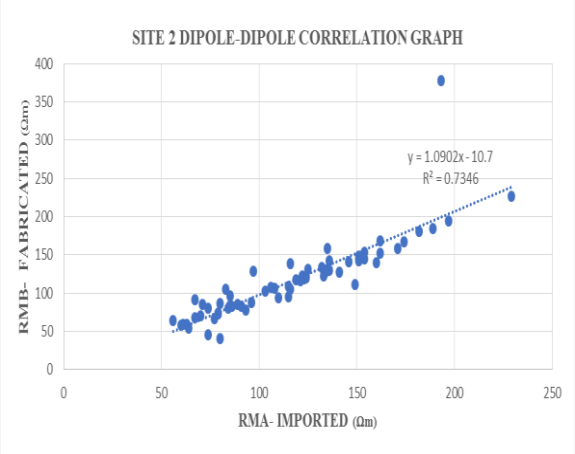


Figure 4: Correlation graph showing the relationship between RMA and RMB

The 2-D resistivity image at Site 1 obtained from both resistivity meters did not delineate the same anomaly feature (Figure 5 and Figure 6). The statistical analysis also confirmed that both resistivity meters do not agree at site 1, showing the Pearson correlation was r = 0.0845 (R^2 = 0.0071), indicating no linear relationship between the two meters' readings. These observed disparities may be attributable to disturbed condition of the near surface material at Site 1, due to ongoing construction work of the university auditorium. This result reveals that each of the resistivity meters responds differently to unfavourable site conditions. The 2-D Sections obtained at Site 2 using RMA and RMB as presented in Figure 7 and Figure 8 showed that both the field data and theoretical data pseudo sections are similar (showing no significant difference). The exactness in observed features shows agreement between the field model and theoretical model; thereby, achieving a lower RMS (0.0615) for the 2-D resistivity structure image. Images of field data pseudo sections, theoretical data pseudo section and 2-D resistivity structure obtained from RMB at site 2, showed similar level of agreement compared to those obtained from RMA; although with a slightly higher RMS error value of 0.0990 for the 2-D resistivity structure. This small RMS error difference was noted to have been due to slight differential in the observed field data, when compared with those obtained from RMA. The 2-D resistivity structure derived at site 2 from both resistivity meters (RMA and RMB) are presented in Figure 7 and Figure 8. It showed that both resistivity meters delineated similar subsurface structure with no excessive significant variance. The 2-D imaging of Site 2 reinforces the statistical findings that the fabricated meter was capable of producing 2-D resistivity data of comparable quality to the imported meter, both in terms of statistical agreement (r = 0.857, p = 0.963) and inversion quality (RMS error = 0.0990). It was noted that Site 2 is an undisturbed location, which may have contributed to quality of observed data at the Site, using both resistivity meters.

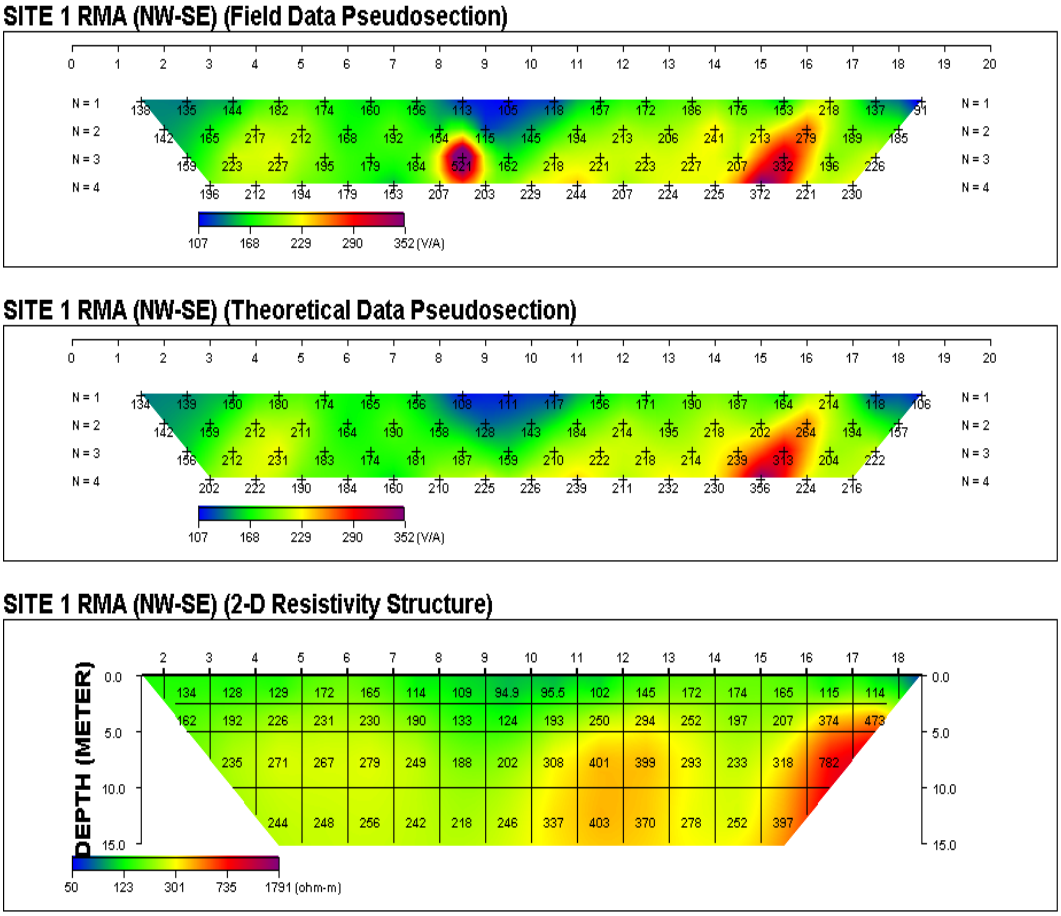


Figure 5: Dipole-dipole field data resistivity pseudosection, theorectical data resistivity pseudosection and 2-D resistivity section at Site 1 for the imported resistivity meter (RMA); RMS Error = 0.0961

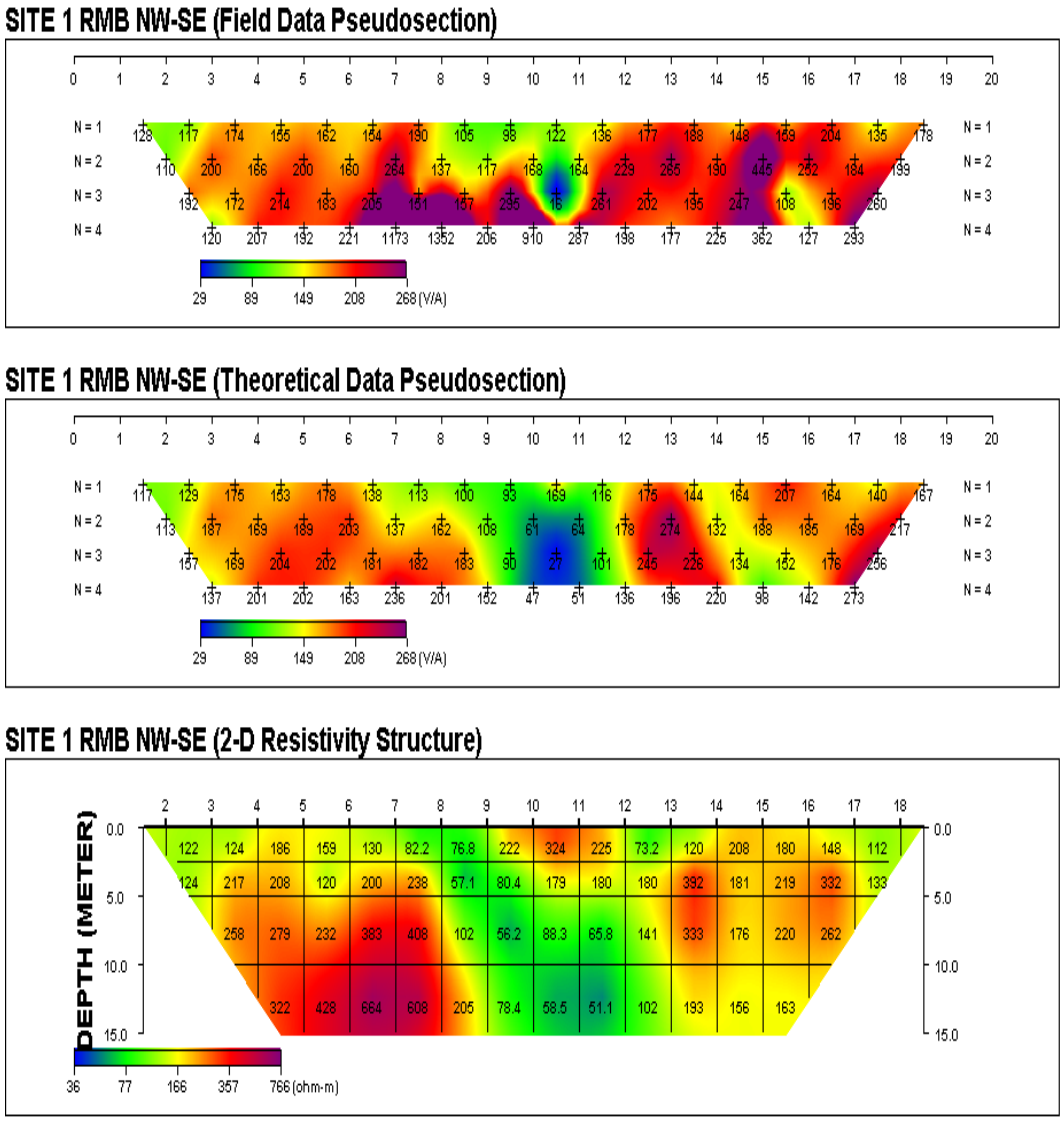


Figure 6: Dipole-dipole field data resistivity pseudosection, theorectical data resistivity pseudosection and 2-D resistivity section at Site 1 for the locally fabricated resistivity meter (RMB); RMS Error = 0.3489

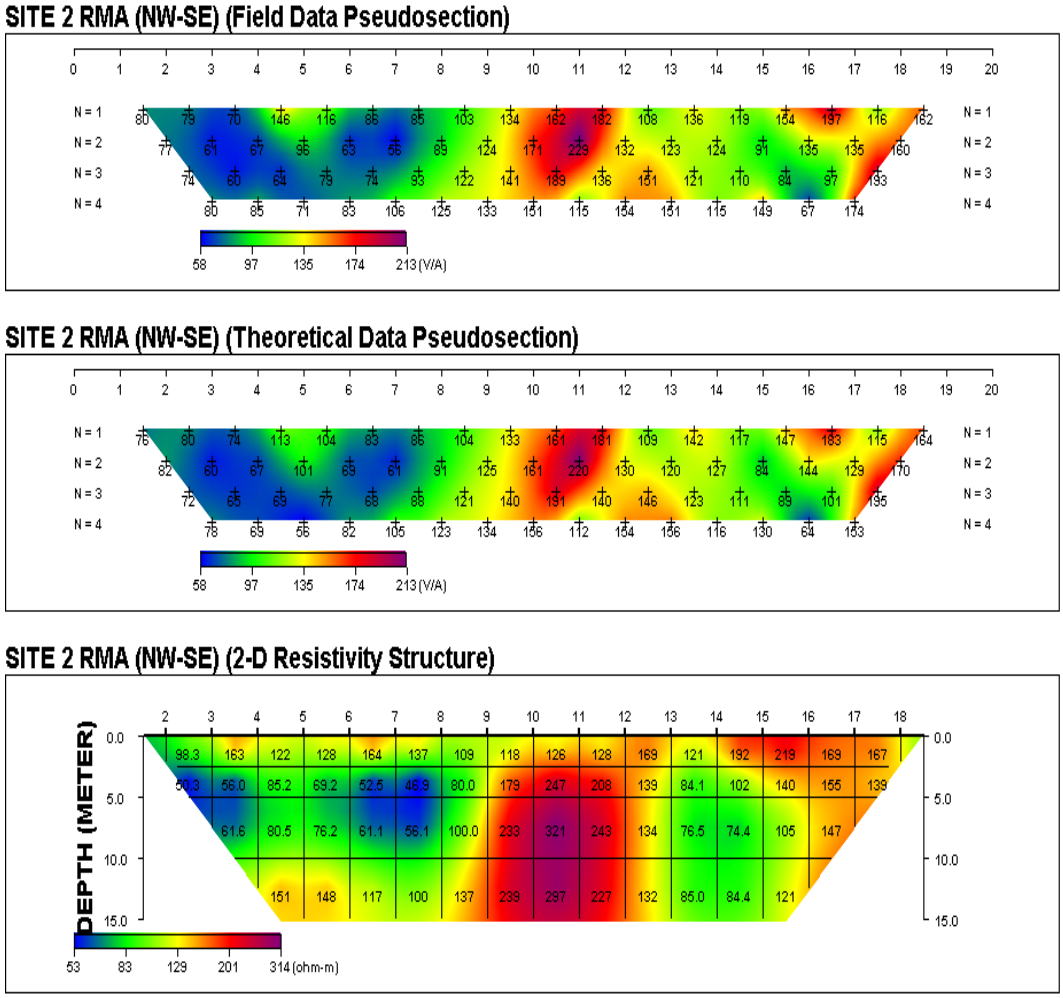


Figure 7: Dipole-dipole field data resistivity pseudosection, theorectical data resistivity pseudosection and 2-D resistivity section at Site 2 for the imported resistivity meter (RMA); RMS Error = 0.0615

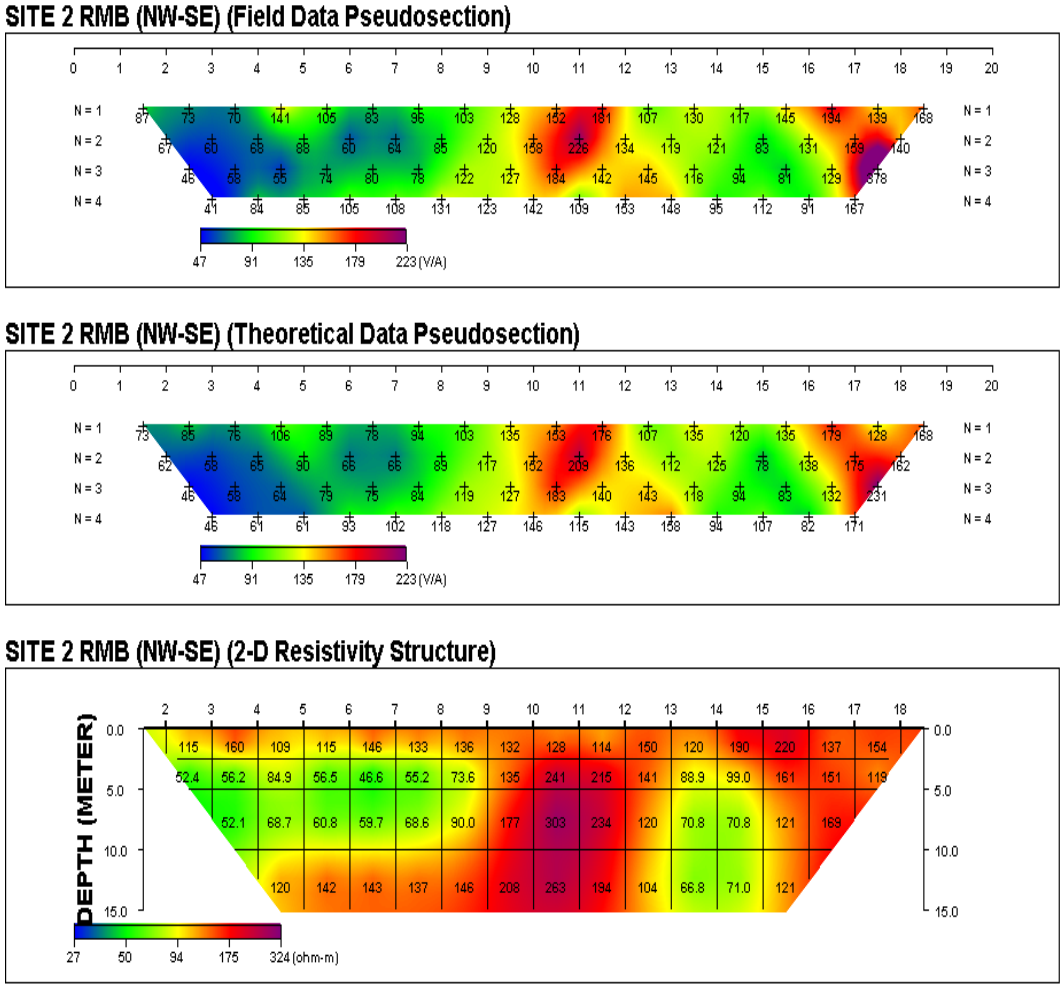


Figure 8: Dipole-dipole field data resistivity pseudosection, theorectical data resistivity pseudosection and 2-D resistivity section at Site 2 for the locally fabricated resistivity meter (RMB); RMS Error = 0.0990

Vertical Electrical Sounding (VES) Statistical Analysis and Depth Sounding Curve Classification

VES surveys were conducted at both sites using the Schlumberger configuration and the Half-Schlumberger configuration. The RMA and RMB recorded apparent resistivity values simultaneously, ensuring a paired statistical comparison at Site 1 and Site 2. Manual partial curve matching was involved in the interpretation of the field data. WinRest software was used in refining the iteration process of the geoelectric models derived from manual interpretations. These analyses were done using Microsoft Excel (Analysis ToolPak).

Site 1 Statistical Analysis

At Site 1 VES 1, 14-paired readings were recorded over AB/2 spacings from 1m to 40 m. Both resistivity meters showed a consistent increased trend in apparent resistivity with depth. Table 4 presents the summarized statistical analysis and depth sounding curve classification. RMA recorded a mean of 182.64 Ωm while RMB recorded 188.28 Ωm, a mean difference of only -5.64 Ωm. The Pearson correlation coefficient was r = 0.9781 (R^2 = 0.9567), indicating excellent agreement between the measurement of the two meters. The RMSE was 19.71 Ωm and the mean percentage difference was 5.94 %, well within the acceptable threshold of 10 %. The paired t-test yielded p = 0.3008 (> 0.05) and t-statistics (t-stat = -1.0775), confirming no statistical significant difference between the resistivity meters performance at VES 1. Both resistivity meter produced similar type curve (H-type curve) with an RMS error for RMA (2.4) and (1.6) for RMB (Table 5).

At Site 1 VES 2, 15-paired readings were recorded over AB/2 spacing from 1 m to 50 m. Table 4 presents the summarized statistical analysis. The mean reading for RMA was 216.6 Ωm and 211.6 Ωm for RMB. The correlation was r = 0.9064 (R^2 = 0.8215), reflecting strong agreement overall.

Table 4: **VES statistical analysis (Site 1 and Site 2)**

VES Stations	Configuration	Pearson Correlation (r)	Mean Difference	Mean % Difference	p-value	RMSE (Ωm)
Site 1 VES 1	Schlumberger	0.9781	-5.64	5.94%	0.3008	19.71
Site 1 VES 2	Schlumberger	0.9064	5	9.53%	0.5656	32.18
Site 1 VES 3	Schlumberger	0.7721	70.33	21.90%	0.0086	111.23
Site 2 VES 1	Schlumberger	0.9942	7.6	5.56%	0.0009	10.16
Site 2 VES 2	Schlumberger	0.9039	-5.27	9.98%	0.4121	23.90
Site 2 VES 3	Half-Schlumberger	0.9687	26	18.39%	0.0014	36.56

(P > 0.05- no significant difference, while p < 0.005- significant difference, Pearson (r) >_ 0.80, strong correlation, while r >_ 0.70, considered acceptable, mean % difference 5- 10 %, acceptable practical agreement, RMSE 10-20 % acceptable agreement)

Table 5: **VES type curve classification and RMS fitting errors — RMA vs RMB**

VES Stations	Site	Configuration	RMA Type Curve	RMB Type Curve	RMS ERROR RMA	RMS ERROR RMB	Layers RMA /RMB	Type Curve Agreement
VES 1	Site 1	Schlumberger	H	H	2.4	1.6	3 / 3	Same type curve
VES 2	Site 1	Schlumberger	HA	HKH	3.0	2.5	4 / 5	Different type curve
VES 3	Site 1	Schlumberger	KHKH	AKH	4.3	4.7	6 / 5	Different type Curve
VES 1	Site 2	Schlumberger	AKH	HKH	2.4	2.4	5 / 5	Different type curve
VES 2	Site 2	Schlumberger	HA	HA	2.4	3.1	4 / 4	Same type Curve
VES 3	Site 2	Half-Schlumberger	KH	KH	2.4	2.7	4 / 4	Same type Curve

However, notable deviations were observed at repeated reading for AB/2 = 6 m, where RMA = 192 Ωm but RMB = 156 Ωm and at repeated AB/2 = 15m, where RMA = 213 Ωm but RMB = 306 Ωm. This localized divergence could reflect electrode contact resistance variations or near-surface heterogeneities. The overall mean percentage difference was 9.53 %. The paired t-test yielded p = 0.5656 and t-statistics (t-stat = 0.5885), confirming no statistical significant difference between the resistivity meters performance at the occupied station. Both resistivity meters did not produced same type curve with an RMS error of (3.0 / 2.5), as presented in Table 5.

Site 1 VES 3 revealed the most notable divergence between both resistivity meters across all acquired data (Table 4). Over 15 paired readings (AB/2 = 1 m to 65 m), RMA recorded a mean of 302.1 Ωm while RMB recorded only 231.8 Ωm, with a mean difference of 70.33 Ωm. The Pearson correlation was r = 0.7721 (R^2 = 0.5962), indicating moderate agreement up to AB/2 = 15m but diverged at larger electrode spacing greater than AB/2 = 15 m. The mean percentage difference was 21.90 %, exceeding the 10 % threshold. The paired t-test yielded p = 0.0086 (< 0.05) and t-statistics (t-stat = 3.0540), indicating a statistical significant difference between the resistivity meters at this sounding location. The RMSE was 111.23 Ωm. This divergence may be attributable to poor electrode contact at greater spacing or instrument sensitivity difference at higher resistivity values; coupled with the disturbed condition of the near surface soils, owing to ongoing construction works. Both resistivity meters did not produce same type curve (KHKH / AKH) and RMS error of (4.3 / 4.7).

Site 2 Statistical Analysis

The summarized statistical analysis and depth sounding curve classification is presented in Table 4. At Site 2, VES 1, 15-paired readings were recorded over AB/2 spacing from 1 m to 50 m. The mean RMA was 170.1 Ωm and mean RMB was 162.5 Ωm. The Pearson correlation was rated high, r = 0.9942 (R^2 = 0.9884), indicating similar behavior across all AB/2 spacing. The RMSE was only 10.16 Ωm and the mean % difference was 5.56 %, well within an acceptable range. Despite high correlation, the paired t-test p =0.0009 (< 0.05) and t-statistics = 4.2185, indicating a statistical significant difference, however the 5.56 % mean difference confirms that both meters are in very close agreement.

Both resistivity meters produce same type curve (AKH / HKH) with an RMS error of (2.4 / 2.4).

VES 2 at Site 2, fifteen (15) paired readings were recorded over AB/2 spacing from 1 m to 65 m. The mean RMA was 132.1 Ωm and mean RMB was 137.4 Ωm. The Pearson correlation was r = 0.9039 (R^2 = 0.08171). The deviations observed at some electrode positions may be because of poor electrode contact. The mean % difference was 9.98%, slightly above the 10% threshold. The paired t-test yielded t-statistics = -0.8454 and p = 0.4121, confirming no statistical difference between both meters. Both resistivity meters produce same type curve (HA / HA) with an RMS error of (2.4 / 3.1).

Owing to spread constraint, the Half-Schlumberger array was engaged for VES 3 at Site 2. Sixteen (16) paired readings over electrode spacing of AB/2 from 1 m to 85 m were acquired. The mean RMA was 162.1 Ωm and mean RMB was 136.1 Ωm, a mean difference of -26 Ωm indicating that RMB consistently recorded lower values than RMA. The Pearson correlation was r = 0.9687), reflecting a strong relationship between both resistivity meter measurements. However, the mean percentage difference was 18.39 %, exceeding the 10 % threshold, and the paired t-test yielded p = 0.0014 (<0.05), indicating a statistical significant difference between both resistivity meters. The largest deviation occurred at AB/2 = 40 m (repeated reading: RMA = 235, RMB = 156; 33.62 % difference) and AB/2 = 65 m (RMA = 371, RMB = 267; 28.03 % difference). The slight variations in the observed field data from RMA and RMB could possibly be due to differences in signal strength, current injection efficiency, sensitivity and attenuation at depth. Both resistivity meters produce same type curve (KH / KH) with an RMS error of (2.4 / 2.7).

Out of the twelve interpreted field data obtained from Sites 1 and 2, both resistivity meters (RMA and RMB) produced the same type curve at three VES locations (i.e. six (6) depth sounding curves). Same and very similar characteristics were obtained at VES 1 at Site 1, and VES 2 and 3 at Site 2 (Table 5), these shows a 50 % curve type agreement. These results establish an acceptable performance of the locally fabricated resistivity meter (RMB) when compared to that of the imported resistivity meter (RMA). Typical type curves obtained using RMA and RMB from Site 1 and 2 are presented in Figs. 9a and b.

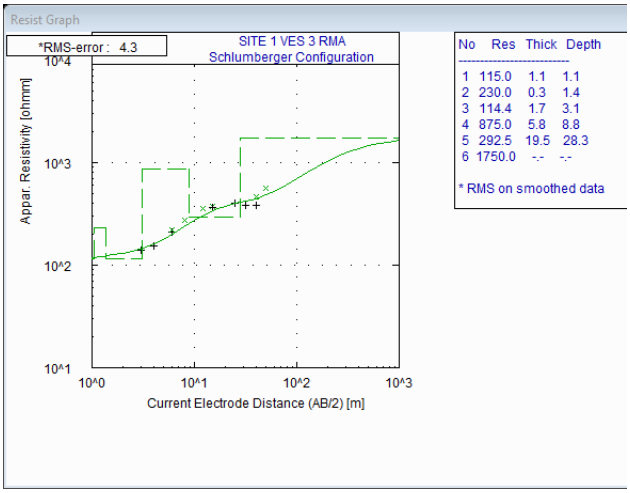


Figure 9a: Site 1 VES 3 RMA (imported resistivity meter), KHKH type curve (RMS Error = 4.3)

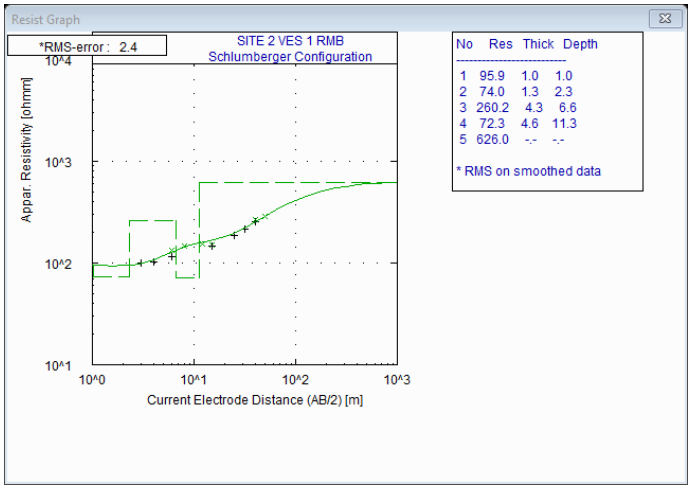


Figure 9b: Site 2 VES 1 RMB (fabricated resistivity meter) HKH type curve (RMS Error = 2.4)

CONCLUSION

A comparative performance evaluation of an imported (Ohmega) resistivity meter (RMA) and a locally fabricated (PZ-02) resistivity meter (RMB) was conducted at two study sites under the same field measurement conditions using dipole-dipole, Schlumberger and Half-Schlumberger array, with both resistivity meters operated simultaneously along the same electrode positions. At Site 1, poor dipole-dipole statistical agreement (r = 0.0845, RMSE = 219.44 Ωm, mean difference = -35.52, mean % difference = 41.93 %) was attributed to extreme outlier readings due to disturbed near surface materials from ongoing construction works, rather than a systematic difference between the meters, as confirmed by the non-significant paired t-test (p = 0.1907). At Site 2, all statistical metrics confirmed strong agreement between the meters (r = 0.8571, RMSE = 25.98 Ωm, p = 0.9627, mean difference = 0.15), with both resistivity meter producing visually similar 2-D inverted structures. For the VES surveys, acceptable performance was recorded at three of the six VES stations, with divergence identified at large electrode spacing. The study concluded that the locally fabricated resistivity meter could be a viable and

cost-effective alternative for near-surface geophysical investigation if improved upon.

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REFERENCES

Adegoke, A. O., Adiat, K. A. N., & Omosuyi, G. O. (2020). Fabrication of resistivity meter and its evaluation within shallow depth of investigation. *Global Journal of Engineering and Technology Advances*, *4(1), 15-29*.

Agung Pratama, Y., & Suharsono, D. (2025). Performance evaluation of ADS 1256 for geoelectric data acquisition system: *Laboratory Scale Comparative Study, Vol. 23, Number 1*.

Ali, A. A., & Alkhalidy, A. A. (2026). Subsurface soil evaluation using 2D electrical resistivity tomography for foundation studies at Najaf City, Iraq. *Iraqi Geological Journal, 59(1), 134–146*. https://doi.org/10.46717/igj.2026.59.1C.10

de la Vega, M., Bongiovanni, M. V., & Grünhut, V. (2021). Design of a low-cost electrical resistivity meter for near surface surveys. *Earth and Space Science*, *8, 1-10pp*. e2020EA001575. https://doi.org/10.1029/2020EA001575

Ogholaja, R. E., Akpoyibo, O., Vwavware, O. J., & Chukwusa, F. O. (2025). Application of dipole-dipole electrical resistivity for subsurface probing within Golf Club centre of University of Benin Teaching Hospital, Benin City. *Nigerian Journal of Theoretical and Environmental Physics, 3(1), 1–9*. https://doi.org/10.62292/njtep.v3i1.2025.65

Oladapo, M. I., Adeoye-Oladapo, O. O., & Mogaji, K. A. (2009). Hydrogeophysical study of the groundwater potential of Ilara-Mokin Southwestern Nigeria. *Global Journal of Pure and Applied Sciences, 15 (2).*

Parsekian, A.D., Harmon, R., Claes, N., Singha, K., Minsley, B.J., Carr, B., Voytek, E., Harmon, R., Kass, A., Carey, A., Thayer, D. & Flinchum, B. (2017). Comparing measurement response and inverted results of electrical resistivity tomography instruments. *Journal of Environmental and Engineering Geophysics, 22(3), 249-266.* DOI: #10.2113/JEEG22.3.249

Rahaman, M.A. (1988). Recent advances in the study of basement complex of Nigeria. In: *Geological Survey of Nigeria, Precambrian Geology of Nigeria, pp. 11-43*.

Reynolds, J. M. (2011). An introduction to applied and environmental geophysics, *(2nd edition). Wiley-Blackwell, 796pp*. *An Introduction to Appliedand Environmental Geophysics*

Telford, W. M., Geldart, L. P., & Sheriff, R. E. (1990). *Applied geophysics, (2nd edition) Cambridge University Press, pp. 344-536.*