

## Application of Electrical Resistivity Method to Decipher Groundwater Occurrence Status at Isikuku, Southern Nigeria

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*Date Received:* 04-07-2022

*Date Accepted:* 10-06-2023

**DOI:** <https://doi.org/10.48198/NJPAS/22.A14>

### ABSTRACT

Electrical resistivity method is a type of geophysical survey employed for groundwater investigation, conducted in Isikuku Community in Benin City, Edo state with the aim of delineating groundwater occurrence. Schlumberger electrode array configuration was employed in this study. Six (6) VES points were surveyed with linearised inversion technique used for the interpretation of sounding taken at various locations in the area. The data collected were interpreted by curved matching and computer iteration using Interpex Ix1D v 2 software. From the geoelectric section, VES 1 possess the AK curve with four layers  $\rho_1 < \rho_2 < \rho_3 > \rho_4$ , VES 2 possess the KQ curve with four layers  $\rho_1 < \rho_2 > \rho_3 > \rho_4$ , VES 3 possess the A curve with three layers  $\rho_1 < \rho_2 < \rho_3$ , VES 4 possess the AK curve with four layers  $\rho_1 < \rho_2 < \rho_3 > \rho_4$ , VES 5 possess the A curve with three layers  $\rho_1 < \rho_2 < \rho_3$ , VES 6 possess the K curve with three layers  $\rho_1 < \rho_2 > \rho_3$ . Geo-electrical layers identified in the study area included topsoil, sandy clay, clay basement and sandstone. The VES study revealed the layer which constitute the productive water-bearing zones referred to as good groundwater potential aquifers. The analysis of the interpretation of the field data showed that the area under investigation delineated four layers earth in each of the vertical electrical sounding point. Generally, the geoelectric survey conducted in the study area revealed the subsurface lithologies: Clay, Clayey Sandstone, Sand stone, Coarse Sand, Lateritic soil and Top soil. Thus, vertical electrical sounding techniques employed in this study has proved useful and successful in delineating subsurface lithology in the study area.

**Keywords:** Aquifer, Geo-electrical Layers, Array, Borehole, Ekiadolor.

### Introduction

Due to Nigeria's constantly rising water demand, particularly in places with insufficient surface water supplies, groundwater exploration is becoming more and more important. Investigations of the characteristics of subsurface layer and groundwater potential have been conducted using resistivity

techniques, particularly the Vertical Electrical Sounding (VES) approach. According to Hadi (2009), this approach is appropriate for hydro-geological surveys in sedimentary rocks. This approach bases the subsurface characterization on how resistivity readings fluctuate with depth.

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Typically, a Schlumberger array is used for a VES, where the potential electrodes are fixed in place with little space between them and the current electrodes are symmetrically positioned on either side of the potential electrodes.

The assessment and evaluation of geologic characteristics like groundwater and the in situ identification of engineering properties are some of the justifications provided by geophysical surveys. Effectiveness is a fundamental requirement for all engineering-geological surveys (Kelly & Mares, 1993), so for a trustworthy investigation of groundwater, key information regarding the depth, location, and extent of groundwater bearing formation requires the use of in-depth and effective techniques (Awosika *et al.*, 2020). Pre-drilling geophysical groundwater exploration is required to prevent drilling dry holes and to offset any potential costs associated with producing subpar groundwater (Ademilua *et al.*, 2014). There are two types of geophysical techniques: active and passive. Passive approaches monitor steady natural fields, whereas active methods inject energy into the ground and track the feedback. Groundwater investigations have used a variety of geophysical techniques that have shown commercial success. The radioactive method, seismic refractive method, magnetic method, electromagnetic method, electrical resistivity method, and gravity method are a few of them.

Ground water volume and distribution are influenced by the host rock formation's geological features. There are many unknowns while looking for ground water, thus it's important to use the proper exploration approaches when defining subsurface water-bearing formations in order to reduce or completely avoid failures (Coker *et al.*, 2009). This study aims at using the Schlumberger

electrode configuration method to delineate the groundwater potential aquifers in the study area.

### **Geology of the Study Area**

The study area, Isikuku communities is in the southern part of Nigeria and lies within longitudes 50 57'E and 50 58'E and latitudes 60 52'N and 60 53'N as shown in figure 1. It has an area of about 400 square kilometers and falls within the tropical equatorial climate. Ground water volume and distribution are influenced by the host rock formation's geological features. There are many unknowns while looking for ground water, thus it's important to use the proper exploration approaches when defining subsurface water-bearing formations in order to reduce or completely avoid failures (Coker *et al.*, 2009). Sand from the continent makes up a sizable portion of the Benin formation. The Niger Delta region as a whole, beginning in the west, extends beyond the present coastline to the south. The Benin formation, which is the most prevalent aquifer in the region, is made up of lone clay/shale interbeds and huge, porous, coarse sands to a degree of over 90% (Allen, 1965). The Ogwashi-Asaba formation, the first aquifer to be found beneath Asaba, is frequently covered by thick, weathered layers of recent sediments and dense vegetation. Despite this, it is heavily utilised for water supply purposes (Akpoborie *et al.*, 2011).

According to Erah *et al.* (2002), the sands, sandstones, and clays range in color from reddish brown to pinkish yellow on worn surfaces to white in the deeper fresh surfaces, and the brown reddish yellowish color is caused by limonitic coatings. In the subsurface, it is older in the north and gets younger and younger towards the south. It generally spans the Miocene to the Recent. Although the thickness varies, it usually reaches 2 kilometers.

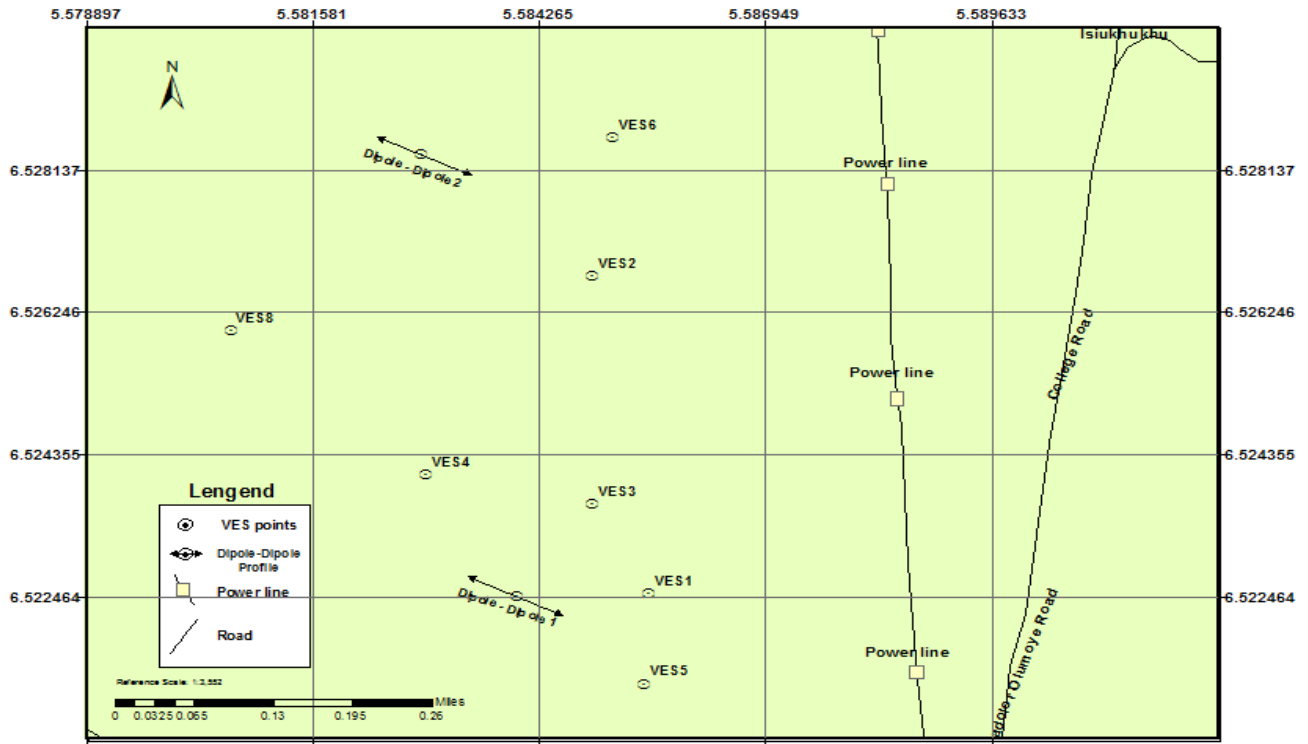


Fig 1: Map showing Study Area and Major Access Roads

**Materials and Methods**

The method employed in this work was adopted from Basse *et al.* (2019). The VES utilized the Schlumberger array. The primary field instrument utilized in this investigation was the ABEM terrameter, which runs on a 12.5v D.C power supply. It digitally shows values for apparent resistivity that were calculated using Ohm's law. Other vital tools employed include the booster, four metal electrodes, cables for potential and current electrodes, hammers, measuring tapes, phones for long distance communication.

The four electrodes in this arrangement (Fig. 2) are arranged symmetrically along a straight line, with the potential electrodes on the inside and the current electrodes on the outside. The current electrodes are moved outside while the potential electrodes are often left in place to alter the depth range of the measurements. The resistance readings were used

for computing the apparent resistivity using Schlumberger electrode configuration based on the following relationship:

$$V = U_M - U_N = \frac{\rho I}{2\pi} \left[ \frac{1}{AM} - \frac{1}{BM} + \frac{1}{BN} - \frac{1}{AN} \right]$$

(Basse *et al.*, 2019)

Where,  $U_M$  and  $U_N$  = potentials at M and N,;

$AM$  = distance between electrodes A and M

$\rho$  = apparent resistivity

$V$  = potential difference (volt, V)

$I$  = electric current (ampere, A).

These distances (Basse *et al.*, 2019) are always the actual distances between the respective electrodes, whether or not they lie on a line. The quantity inside the brackets is a function only of the various

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electrode spacing. The quantity is denoted  $1/K$ , which allows rewriting the equation as:

$$V = \frac{\rho l}{2\pi} \left[ \frac{1}{K} \right], \quad (\text{Bassey et al., 2019})$$

Where  $K$  = array geometric factor that depends on the arrangement of the four electrodes A, B, M and N.

To obtain the resistivity,  $\rho$ :

$$\rho = 2\pi K \frac{V}{I}, \quad (\text{Bassey et al., 2019})$$

The resistivity of the medium can be found from measured values of  $V$ ,  $I$ , and  $K$ .

The aforementioned equations apply as long as the depth of investigation is a function of electrode spacing and the current electrode spread  $AB/2$  is equal to or more than five times the potential electrode spread  $MN/2$ . Based on the prevailing geologic condition during the survey, a maximum outer electrode spacing of 215m was made at the sounding station. The potential electrodes must also be moved outward when the distance between the potential electrodes and the distance between the current electrodes gets excessively big, or else the potential difference will be too tiny to be recorded accurately (Koefoed, 1979).. Measurements of current and potential electrode positions are marked such that:

$$AB/2 \geq MN/2, \quad (\text{Bassey et al., 2019})$$

Where;  $AB/2$  = current electrode spacing;  $MN/2$  = potential electrode spacing.

The Vertical Electrical Sounding data are plotted and inverted using IPI2win software which creates a 1-D model from the sounding data. The geological interpretation was done using the representative values of resistivity while Strater 3 software was used to draw the 1D subsurface model for visualization. Each geoelectric layer's longitudinal conductance, transverse resistance, and Dar Zarrouk characteristics were calculated. According to Ward (1990), an aquifer's transverse resistance closely

correlates with its transmissivity. The longitudinal conductance and the conductivity of geologic material are directly inversely correlated. The electrical reflection coefficient of each geo-electric boundary; longitudinal conductance and transverse resistance were computed using the formulas:

$$RRC = [(\rho_n - \rho_{n-1} / \rho_n + \rho_{n-1})]$$

$$RC = [(\rho_n / \rho_{n-1})]$$

$$T = \sum h_i \rho_i = h_1 \rho_1 + h_2 \rho_2 + \dots h_n \rho_n \text{ (ohm - m}^2\text{)}$$

$$S = \sum h_i / \rho_i = h_1 / \rho_1 + h_2 / \rho_2 \dots h_n / \rho_n \text{ (mho)}$$

(Bassey et al., 2019)

Where: RRC = Resistivity reflection coefficient; RC = Resistivity contrast; T = Total transverse resistance, S = Total longitudinal conductance;  $\rho_n$  = Resistivity of the nth layer;  $\rho_{n-1}$  = Resistivity of the (n-1)th layer,  $h_n$  = Thickness of the nth layer.



**Plate 1:** ABEM terrameter SAS 300

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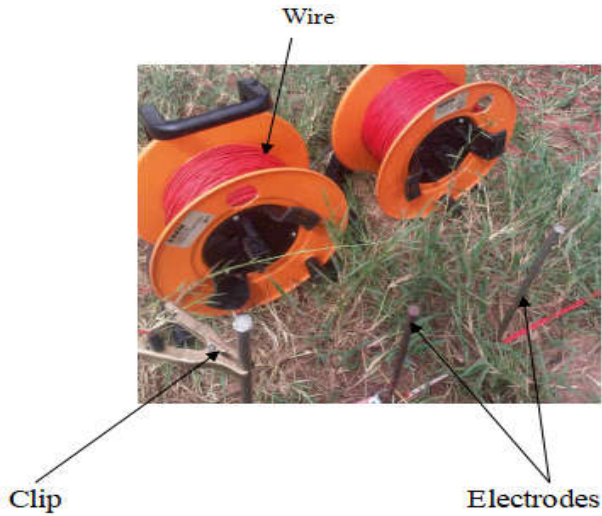


Plate 2: Electrodes, cables, clip

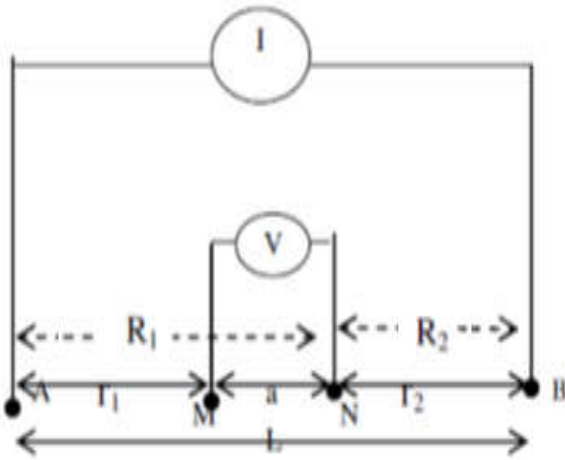


Fig 2: Schlumberger Field Electrode Array (Zohdy, 1988)

Where  $a$  = distance between the potential electrodes

$L$  = distance between current electrodes

$R_1$  &  $R_2$  = Resistance distances between current and potential electrodes

$I_1$  &  $I_2$  = Current distances between current and potential electrodes

**Result**

The results of the interpretation of the various VES locations in Table 1 - 12 showed the number of geoelectric layers in each of the sounding points. It also showed the layer resistivities, thicknesses and depths, including the lithologies obtained from the computed assisted Interpex I x 1D v 2 software.

Table1: Apparent Resistivity data for VES1

| AB/2   | MN    | $\rho$  |
|--------|-------|---------|
| 1.00   | 0.40  | 471.00  |
| 1.47   | 0.40  | 651.00  |
| 2.15   | 0.40  | 905.00  |
| 3.16   | 0.40  | 1175.00 |
| 4.64   | 0.40  | 1500.00 |
| 6.81   | 0.40  | 1750.00 |
| 10.00  | 0.40  | 1950.00 |
| 14.70  | 0.40  | 2010.00 |
| 21.50  | 0.40  | 2055    |
| 31.60  | 4.00  | 2881    |
| 46.40  | 20.00 | 4008    |
| 68.10  | 20.00 | 5345    |
| 100.00 | 20.00 | 6555    |
| 147.00 | 20.00 | 7525    |
| 215.00 | 80.00 | 7860    |
| 316.00 | 80.00 | 7480    |

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**Table 2:** showing sub-surface characteristics of VES 1 points

| VES1  |                  |                  |               |                      |
|-------|------------------|------------------|---------------|----------------------|
| Layer | Resistivity (Ωm) | Depth to Top (m) | Thickness (m) | Inferred Lithology   |
| 1     | 184.79           | 0.36169          | 0.36169       | Top Soil (Lateritic) |
| 2     | 5785.7           | 1.7639           | 1.4022        | Clayey Sandstone     |
| 3     | 533.58           | 5.3936           | 3.6297        | Coarse Sand          |
| 4     | 19991.0          | 49.005           | 43.611        | Clayey Sandstone     |
| 5     | 6256.6           | 104.17           | 55.163        | Clayey Sandstone     |
| 6     | 5386             | -                | -             | -                    |

**Table 4:** showing sub-surface characteristics of VES 2 points

| VES2  |                 |                 |              |                    |
|-------|-----------------|-----------------|--------------|--------------------|
| Layer | Resistivity(Ωm) | Depth to Top(m) | Thickness(m) | Inferred Lithology |
| 1     | 433.96          | 0.98014         | 0.98014      | Lateritic soil     |
| 2     | 1412.5          | 5.3888          | 6.3689       | Wet sand           |
| 3     | 5314.8          | 9.3563          | 2.9874       | Sand stone         |
| 4     | 1284.5          | 11.877          | 2.5212       | Wet sand           |
| 5     | 495.84          | 4.7543          | 16.632       | Clayey sandstone   |
| 6     | 3619            | 36.083          | 19.451       | Clayey sandstone   |
| 7     | 88.402          |                 |              |                    |

**Table 3:** Apparent Resistivity data for VES 2

| AB/2   | MN    | <i>p</i> |
|--------|-------|----------|
| 1.00   | 0.40  | 480.30   |
| 1.47   | 0.40  | 548.11   |
| 2.15   | 0.40  | 639.72   |
| 3.16   | 0.40  | 805.99   |
| 4.64   | 0.40  | 988.65   |
| 6.81   | 0.40  | 891.80   |
| 10.00  | 0.40  | 1400.00  |
| 14.70  | 0.40  | 1400.00  |
| 21.50  | 0.40  | 1760.00  |
| 31.60  | 4.00  | 2100.00  |
| 46.40  | 20.00 | 2500.00  |
| 68.10  | 20.00 | 3010.00  |
| 100.00 | 20.00 | 3570.00  |
| 147.00 | 20.00 | 4000.00  |
| 215.00 | 80.00 | 3620.00  |
| 316.00 | 80.00 | 2700.00  |

**Table 5:** Apparent Resistivity data for VES 3

| AB/2   | MN    | <i>p</i> |
|--------|-------|----------|
| 1.00   | 0.40  | 158.34   |
| 1.47   | 0.40  | 186.76   |
| 2.15   | 0.40  | 227.16   |
| 3.16   | 0.40  | 257.73   |
| 4.64   | 0.40  | 304.17   |
| 6.81   | 0.40  | 346.16   |
| 10.00  | 0.40  | 416.05   |
| 14.70  | 0.40  | 542.06   |
| 21.50  | 0.40  | 760.40   |
| 31.60  | 4.00  | 900.00   |
| 46.40  | 20.00 | 1600.00  |
| 68.10  | 20.00 | 2000.00  |
| 100.00 | 20.00 | 3520.00  |
| 147.00 | 20.00 | 3000.00  |
| 215.00 | 80.00 | 3000.00  |
| 316.00 | 80.00 | 3850.00  |

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**Table 6:** Showing sub-surface characteristics of VES 3 points

| VES 3 |                  |                 |               |                    |
|-------|------------------|-----------------|---------------|--------------------|
| Layer | Resistivity (Ωm) | Depth to Top(m) | Thickness (m) | Inferred Lithology |
| 1     | 144.90           | 1.1044          | 1.1044        | Top soil           |
| 2     | 1550.3           | 0.48304         | 1.5874        | Lateritic soil     |
| 3     | 329.88           | 6.4649          | 8.0523        | Wet sand           |
| 4     | 17023.           | 36.192          | 44.244        | Sand stone         |
| 5     | 6941.2           | 40.361          | 84.605        | Clayey sandstone   |
| 6     | 406.98           |                 |               |                    |

**Table 7:** Apparent Resistivity data for VES 4

| AB/2   | MN    | <i>p</i> |
|--------|-------|----------|
| 1.00   | 0.40  | 332.74   |
| 1.47   | 0.40  | 397.78   |
| 2.15   | 0.40  | 532.74   |
| 3.16   | 0.40  | 651.46   |
| 4.64   | 0.40  | 713.40   |
| 6.81   | 0.40  | 703.54   |
| 10.00  | 0.40  | 950.41   |
| 14.70  | 0.40  | 1452.44  |
| 21.50  | 0.40  | 1803.32  |
| 31.60  | 4.00  | 2390.81  |
| 46.40  | 20.00 | 2466.16  |
| 68.10  | 20.00 | 2790.68  |
| 100.00 | 20.00 | 2848.76  |
| 147.00 | 20.00 | 3054.61  |
| 215.00 | 80.00 | 3050.67  |
| 316.00 | 80.00 | 2709.02  |

**Table 8:** showing sub-surface characteristics of VES 4 points

| VES 4 |                 |                 |              |                    |
|-------|-----------------|-----------------|--------------|--------------------|
| Layer | Resistivity(Ωm) | Depth to Top(m) | Thickness(m) | Inferred Lithology |
| 1     | 139.21          | 0.36445         | 0.36445      | Top soil           |
| 2     | 2200.9          | 1.0962          | 0.73178      | Lateritic soil     |
| 3     | 202.96          | 2.2773          | 1.1811       | Wet sand           |
| 4     | 1357.0          | 7.9167          | 5.6393       | Wet sand           |
| 5     | 1223.2          | 29.122          | 21.206       | Wet sand           |
| 6     | 6965.3          | 103.22          | 74.099       | Sand stone         |
| 7     | 834.62          | -               | -            | -                  |

**Table 9:** Apparent Resistivity data for VES 5

| AB/2   | Resistivity(Ωm) | MN    | <i>p</i> |
|--------|-----------------|-------|----------|
| 1.00   | 645.14          | 0.40  | 260.00   |
| 1.47   | 844.01          | 0.40  | 380.00   |
| 2.15   | 1334.80         | 0.40  | 500.00   |
| 3.16   | 1811.79         | 0.40  | 740.00   |
| 4.64   | 2246.84         | 0.40  | 720.00   |
| 6.81   | 2570.44         | 0.40  | 800.00   |
| 10.00  | 2688.75         | 0.40  | 1100.00  |
| 14.70  | 2570.88         | 0.40  | 1570.00  |
| 21.50  | 2414.20         | 0.40  | 1800.00  |
| 31.60  | 2594.71         | 4.00  | 2200.00  |
| 46.40  | 3132.52         | 20.00 | 2500.00  |
| 68.10  | 3814.75         | 20.00 | 2780.00  |
| 100.00 | 4566.35         | 20.00 | 2820.00  |
| 147.00 | 4949.77         | 20.00 | 3000.00  |
| 215.00 | 4820.90         | 80.00 | 2900.00  |

**Table 10:** showing sub-surface characteristics of VES 5 points

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| VES 5 |                                  |                  |               |                       |
|-------|----------------------------------|------------------|---------------|-----------------------|
| Layer | Resistivity ( $\Omega\text{m}$ ) | Depth to Top (m) | Thickness (m) | Inferred Lithology    |
| 1     | 93.273                           | 0.39             | 0.39          | Lateritic (weathered) |
| 2     | 3936.4                           | 1.95             | 1.56          | Lateritic (weathered) |
| 3     | 200.64                           | 9.59             | 7.64          | Alluvial Sand         |
| 4     | 11067.                           | 70.91            | 61.32         | Lateritic             |
| 5     | 2095.1                           | -                | -             | Lateritic             |

**Table 11:** Apparent Resistivity data for VES 6

| AB/2   | MN    | $\rho$  |
|--------|-------|---------|
| 1.00   | 0.40  | 317.43  |
| 1.47   | 0.40  | 422.16  |
| 2.15   | 0.40  | 522.72  |
| 3.16   | 0.40  | 650.82  |
| 4.64   | 0.40  | 820.77  |
| 6.81   | 0.40  | 1157.52 |
| 10.00  | 0.40  | 1411.95 |
| 14.70  | 0.40  | 1800.26 |
| 21.50  | 0.40  | 2300.00 |
| 31.60  | 4.00  | 2800.04 |
| 46.40  | 20.00 | 3000.01 |
| 68.10  | 20.00 | 2850.00 |
| 100.00 | 20.00 | 3000.00 |
| 147.00 | 20.00 | 3050.00 |
| 215.00 | 80.00 | 3000.00 |
| 316.00 | 80.00 | 2600.00 |

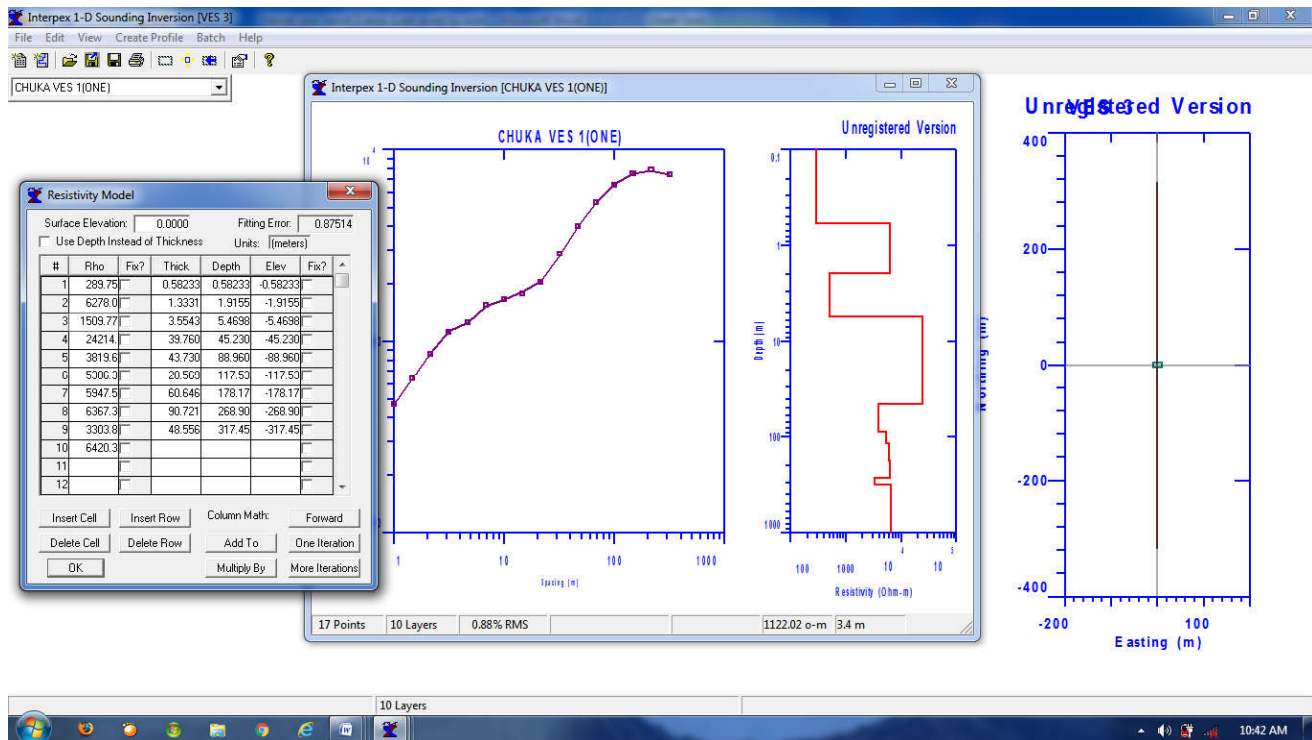


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**Table 12:** showing sub-surface characteristics of VES 6 points

| VES6  |                          |                 |              |                    |
|-------|--------------------------|-----------------|--------------|--------------------|
| Layer | Resistivity( $\Omega$ m) | Depth to Top(m) | Thickness(m) | Inferred Lithology |
| 1     | 221.05                   | 0.56166         | 0.56166      | Top soil           |
| 2     | 1105.4                   | 3.9552          | 3.3935       | Lateritic soil     |
| 3     | 6935.6                   | 14.793          | 10.838       | Sand stone         |
| 4     | 4522.8                   | 28.980          | 14.187       | Sand stone         |
| 5     | 2856.7                   | 59.344          | 30.363       | Clayey Sandstone   |
| 6     | 2913.6                   |                 |              |                    |

**Presentation of the Curves and Geoelectric Model for VES 1-6**



**Figure 3:** VES 1 Curve

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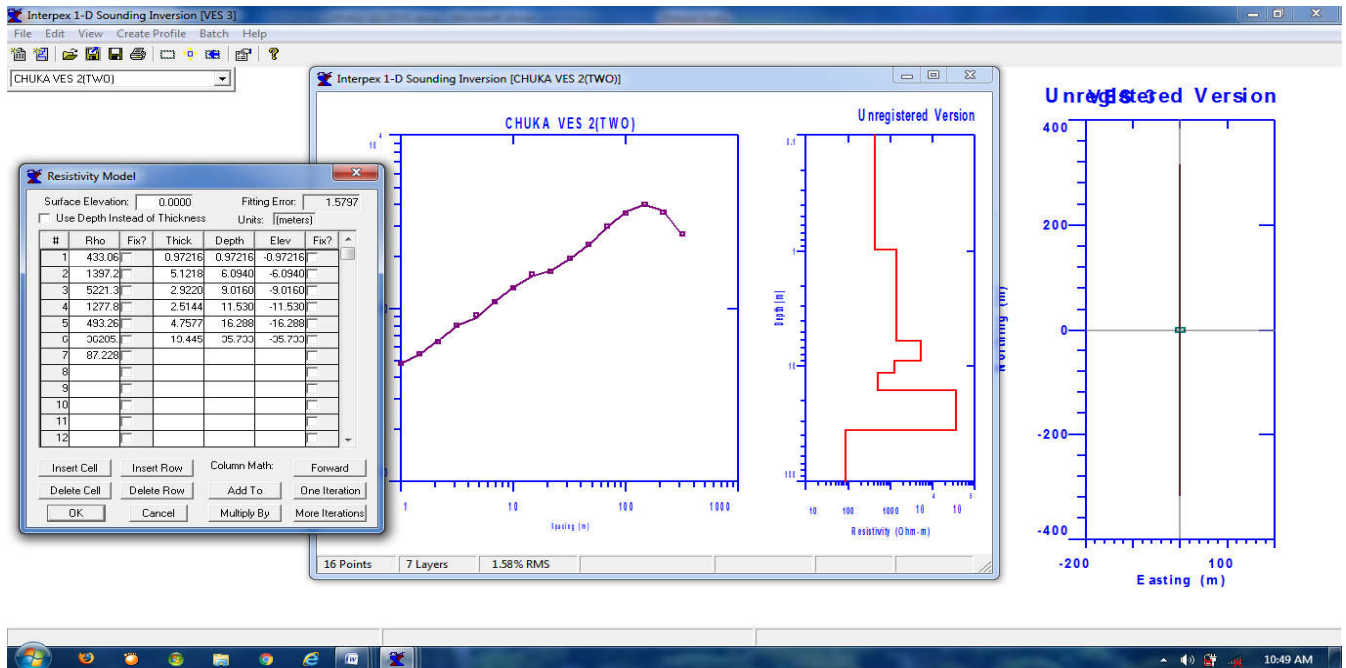


Figure 4: VES 2 Curve

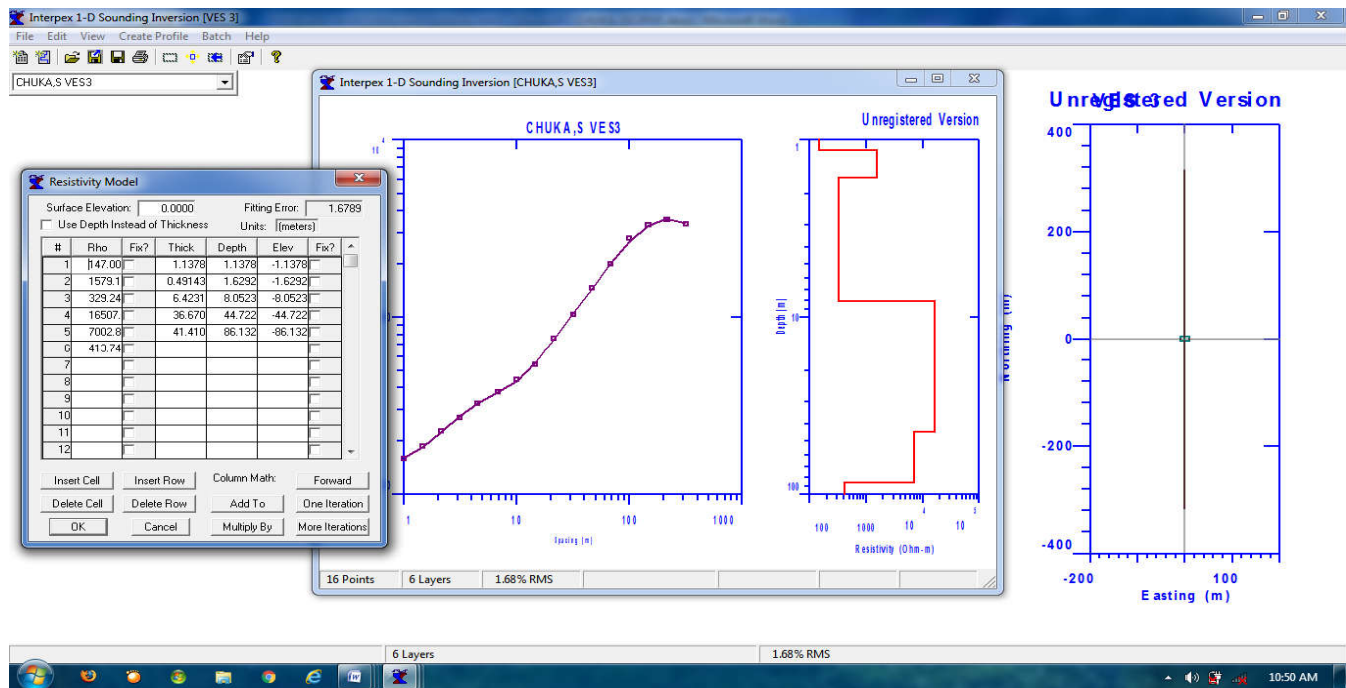


Figure 5: VES 3 Curve

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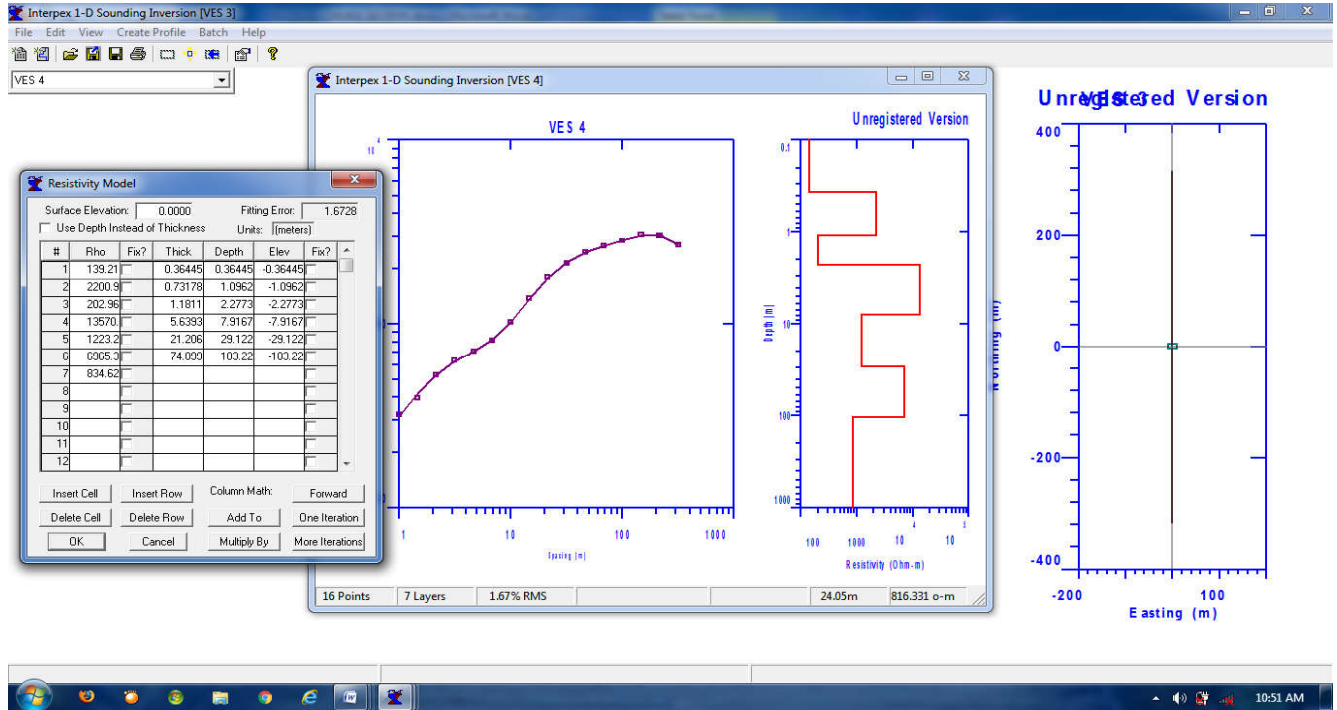


Figure 6: VES 4 Curve

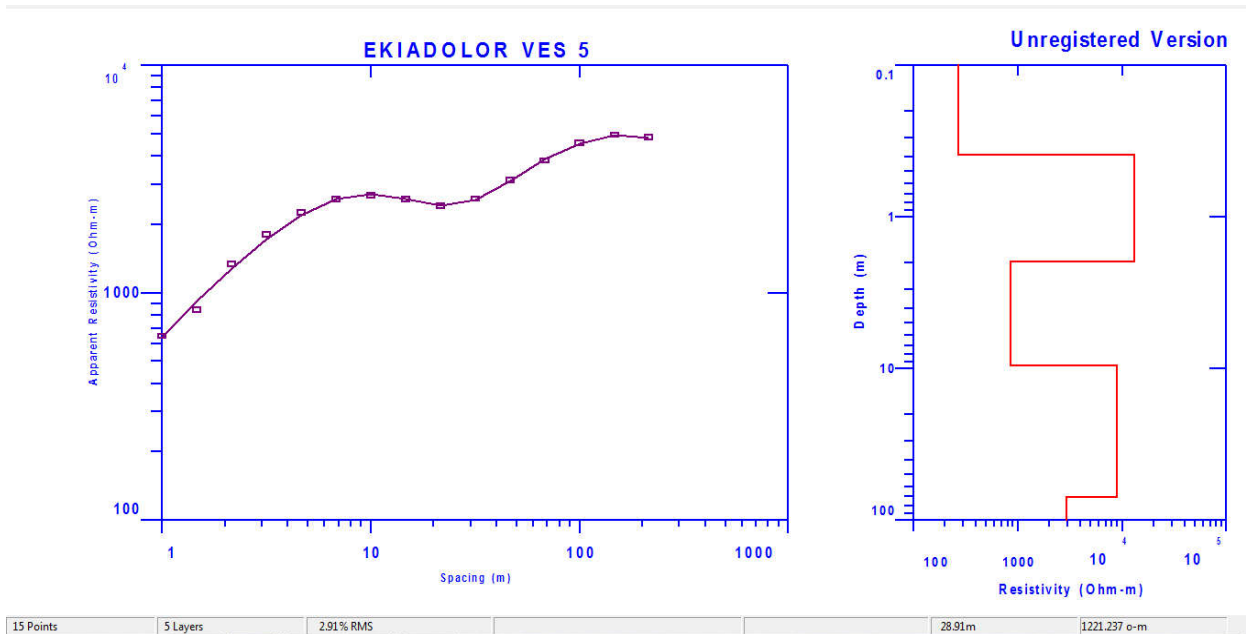


Figure 7: VES 5 Curve

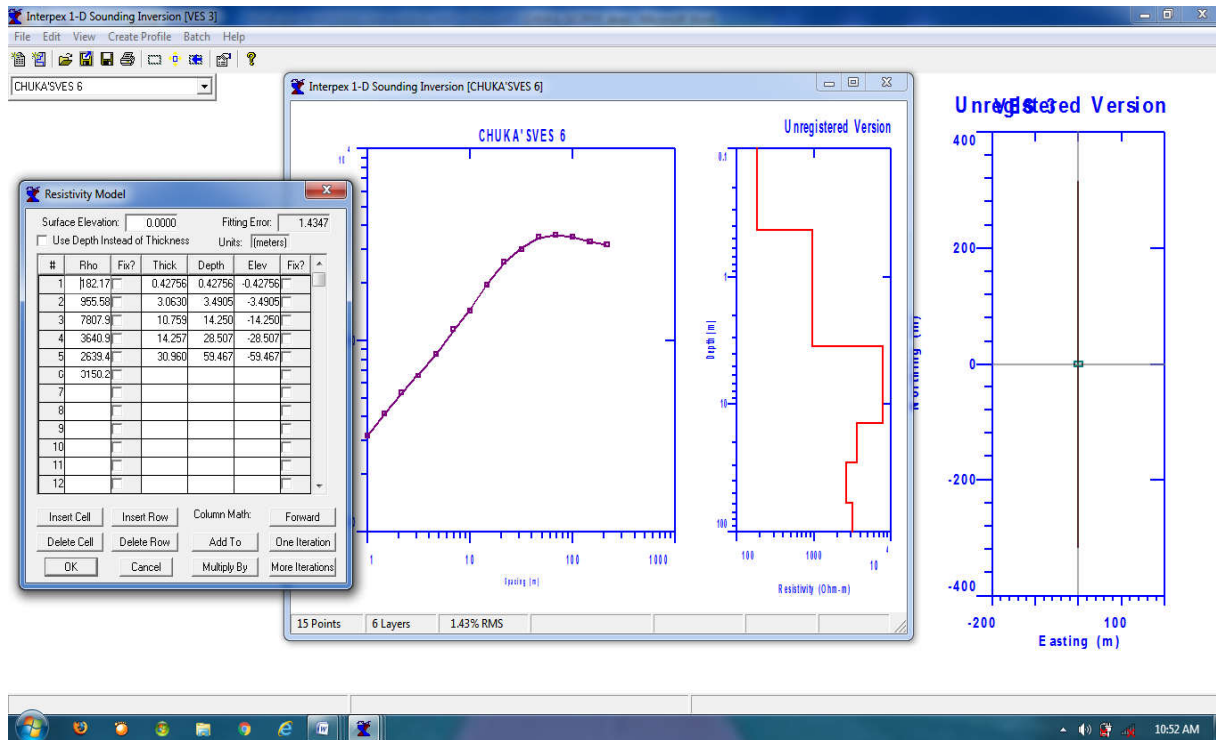


Figure 8: VES 6 Curve

### Discussion

As shown in the geoelectric models and in Tables 2, 4, 6, 8, 10 & 12, each geological layer characteristics were accessed according to the Interpex I x 1D v 2 software. Every layer in each VES point was carefully analyzed. The mentioned tables also showed the layer resistivities, thicknesses and depths, including the lithologies obtained from the computed assisted Interpex I x 1D v 2 software.

From the geoelectric section, VES 1 possess the AK curve with four layers  $\rho_1 < \rho_2 < \rho_3 > \rho_4$ , VES 2 possess the KQ curve with four layers  $\rho_1 < \rho_2 > \rho_3 > \rho_4$ , VES 3 possess the A curve with three layers  $\rho_1 < \rho_2 < \rho_3$ , VES 4 possess the AK curve with four layers  $\rho_1 < \rho_2 < \rho_3 > \rho_4$ , VES 5 possess the A curve with three layers  $\rho_1 < \rho_2 < \rho_3$ , VES 6 possess the K curve with three layers  $\rho_1 < \rho_2 > \rho_3$ .

Data obtained from the survey revealed that VES 1 has the least thickness value of 0.36169 m in its first layer, composed of the Benin Lateritic top soil, while the fifth layer of VES 3 has the highest thickness of 84.605 m and depth-to-top value of 40.361 m, which is indicative of the most viable potential for groundwater accumulation (Obiora *et al.*, 2016) as compared to the other VES points. This is followed by the sixth layer of VES 4 and the fourth layer of VES 5 having a thickness of 74.099 m and 61.32 m, respectively. Although VES 3 is suggestive as the the area with the most reliable potential as compared to the other VES investigated points which may be vulnerable to contamination from leachate. According to Obiora *et al.* (2016), an area with low value thickness is seen to possess a weak aquifer protective capacity as compared to other VES with higher thickness values.

The results of the interpretation of the various VES locations in Tables 2, 4, 6, 8, 10 & 12,

showed the number of geoelectric layers in each of the sounding points. Every first-layer, second-layer, third-layer, fourth-layer and fifth layer in each VES point was carefully analyzed. The resistivity values of VES 1 ranges from 184.79  $\Omega\text{m}$  – 19991.0  $\Omega\text{m}$  and thickness range from 0.36169 m - 55.163 m, VES 2 having resistivity range of 433.96  $\Omega\text{m}$  - 5314.8  $\Omega\text{m}$  and thickness range from 0.98014 m - 16.632 m, VES 3 having resistivity range of 144.90  $\Omega\text{m}$  - 6941.2  $\Omega\text{m}$  and thickness range from 1.1044 m - 84.605 m, VES 4 having resistivity range of 139.21  $\Omega\text{m}$  - 2200.9  $\Omega\text{m}$  and thickness range from 0.36445 m - 21.206 m, VES 5 having resistivity range of 93.273  $\Omega\text{m}$  - 3936.4  $\Omega\text{m}$ . VES 6 having resistivity range of 221.05  $\Omega\text{m}$  - 6935.6  $\Omega\text{m}$  and thickness range from 0.56166 m - 30.363 m.

In Table 2, the common phenomenon from the analysis revealed that the fourth-layer of VES 1 is highly resistive, while Table 10 showed that the first-layer of VES 5 has very low resistivity. This implies geophysically, that there exists common geological features underlain the study area, which also indicated generally in all curves presented, the ascending nature of the VES curves indicates homogeneity of the study area (Ezomo and Aigbogun, 2012).

### Conclusion

The whole study revealed that the identification of highly conductive probable water-bearing zones using electrical techniques may successfully be used to conduct groundwater prospecting in regions with low groundwater prospects. Areas with low resistivity values in most cases are suggestive of high conductivity, however, aquifer depth need be taken into consideration so as to drill from subsurface region quite below the water table in order to obtain water with minimal contamination. It is worthy of note that good prospects exist for groundwater development where the depth to basement is relatively thick and has relatively low resistivity, while those with thin thickness

and high resistivity value have a lower potential for an aquifer. Moreover, electrical resistivity method gives reasonably good results among other methods that can be used to understand the subsurface layers and basement configuration in groundwater prospecting.

The analysis of the interpretation of the field data showed that the area under investigation delineated four layers earth in each of the sounding point. Generally, the geoelectric survey conducted in the study area revealed the subsurface lithologies: Clay, Clayey Sandstone, Sand stone, Coarse Sand, Lateritic soil and Top soil. Thus, vertical electrical sounding techniques employed in this study has proved useful and successful in delineating subsurface lithology in the study area.

Conclusively, it is important to add that this work is a guide to delineate drill points and does not determine the volume of water underground, as that can only be determined by pump testing during borehole development.

### Conflict of Interest

Authors hereby declare that there is no conflict of interest.

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