

## PATTERN OF ELECTRICAL RESISTIVITY IN REGOLITH AQUIFER AND THEIR IMPLICATION FOR GROUNDWATER MANAGEMENT IN ILORIN METROPOLIS, NIGERIA

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### Abstract

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Groundwater development in basement complex terrains is largely dependent on the occurrence and characteristics of the regolith aquifer, making geophysical investigation a vital precursor to borehole siting. This paper examines the pattern of electrical resistivity in the regolith aquifer of Ilorin metropolis, Kwara State, Nigeria. Forty (40) Vertical Electrical Sounding (VES) points were established across the study area to delineate subsurface lithological layers, determine resistivity patterns, and estimate weathering depth. The resistivity data were processed and interpreted using computer iteration techniques, while an aquifer potential index was used to evaluate groundwater potential. The findings reveal a geo-electric sequence of five lithological layers, comprising topsoil, lateritic layer, clayey soil, weathered basement, and fresh basement, with resistivity curve types identified as H, K, A, and Q. The regolith aquifer, represented by the weathered basement, recorded resistivity values ranging from 3.57Ωm to 297Ωm, while weathering depth varied from 3.30 m to 31.28 m, with both parameters showing higher values in the south-western and north-eastern parts of the study area. Analysis indicated that 45% of the study area exhibited optimum weathering and groundwater potential, whereas correlation analysis revealed a weak inverse relationship ( $r = -0.361$ ) between regolith resistivity and aquifer potential, suggesting that resistivity alone is insufficient predictor of groundwater yield. The study concludes that the regolith aquifer constitutes the principal groundwater reservoir in the study area. Recommendations include the adoption of pre-drilling geophysical surveys as a mandatory practice and the prioritization of boreholes in zones identified with optimum aquifer potential.

**Keywords:** Vertical Electrical Sounding, Regolith Aquifer, Groundwater Potential, Resistivity, Weathering Depth.

### Introduction

Water is an important natural resource needed for the survival of man and the development of a nation. Although a larger percentage (97 percent) of the water on the earth is salt water (ocean water) and is not suitable for human consumption (WWAP, 2015). Moreover, the quality of freshwater resources available for human consumption has degraded due to anthropogenic activities along many rivers, lakes, and streams. Hence, previous studies (Hasan, *et al.*, 2021; Chen, *et al.*, 2018) observed that groundwater has advantages over other sources of water in terms of wide distribution, high

quality, and reliability during extreme hydrometeorological events such as drought. Groundwater is the largest available freshwater resource on earth that supports human health, socioeconomic and environmental development, and ecological diversity (Guo et al., 2023; Xiong et al., 2022). The UNESCO (2015) estimated that about 2.5 billion people globally depend on groundwater resources for their daily activities. Tukur *et al.*, (2018) further posited that 28.9% of Nigerians depend on groundwater resources, particularly in areas characterized by erratic rainfall, prolonged dry seasons, and inadequate surface water supply. Hence, groundwater stored within regolith and fractured basement aquifers supports domestic water supply, agriculture, and industrial activities (Ejepu *et al.*, 2024).

Many studies have been carried out on groundwater, most of which are mainly geological, geophysical, and hydrogeological investigations. For instance, Olorunfemi and Fasuyi (1993) delineated the aquifer types in Kano state, and Bala (2001) assessed the usefulness of Landsat-5 Thematic Mapper I imagery in groundwater exploration in basement complex rocks of Kano and Zaria-Kaduna areas. Bawallah *et al.*, (2018) modeled groundwater potentials around Kwara State using the electrical resistivity method to determine the geoelectric parameters in evaluating the groundwater potentials. Similarly, numerous studies have delineated groundwater potential zones in their areas of interest using the GIS approach (Saraf and Choudhury, 1998; Jha and Peiffer, 2006).

Electrical resistivity methods are important in hydrogeological studies; they are not only cost-effective but also provide valuable information regarding subsurface characteristics and groundwater resources such as aquifer geometry, groundwater potential, contamination pathways, and aquifer vulnerability (Udosen et al., 2024). These methods can detect variations in moisture level and soil composition (Singha, 2017); and the broad range of electrical resistivity values stretching from less than 1  $\Omega.m$  to thousands of  $\Omega.m$  is a primary reason why these methods are effective for subsurface mapping (Kumar, 2012; Kumar *et al.*, 2014). Therefore, the techniques serve as essential tools for understanding the complex interaction between surface water and underground reservoirs (Benabdelouahab *et al.*, 2019). These approaches are necessary for predicting and enhancement of groundwater resource management, as they provide crucial information about the depth variation of the aquifers. Moreover, in developing a reliable groundwater potential zone, a lot of variables are commonly involved. In other words, the occurrence, movement, and distribution of groundwater in an area are governed by several factors such as lithology, vegetation, geological structures, soil, lineament features, slope, drainage pattern, geomorphology, land use/land cover, and the interrelationship between these factors (Jha *et al.*, 2010; Chowdhury *et al.*, 2010).

Ilorin Metropolis is faced with increasing water crises as the demand for water now exceeds supply. Many of the rural communities in the study area rely on rivers, streams, and shallow wells for their daily water needs, while some of the urban dwellers rely on privately owned shallow wells and boreholes. The public water infrastructure in many of the communities is characterized by frequent breakdowns, dry taps, poor coverage, old reticulation systems, abandoned water projects, among others. Experience has shown that these shallow wells dry up immediately after rain ceases. Hence, the issue is not only about water availability, but rather, it is about its reliability, safety, accessibility within reasonable proximity, and sufficiency for human needs.

Furthermore, the fact that aquifers are out of sight and not often known made groundwater resources suffer from the “hidden treasure” syndrome. Several boreholes are drilled in the study area, to provide community water supplies. However, some boreholes are unsuccessful because the boreholes do not encounter water-bearing fractures, or some of the fractures are not hydraulically interconnected to provide sufficient water to the boreholes. This hinders efforts to providing and

managing groundwater resources sustainably. Therefore, the study examines the pattern of electrical resistivity in regolith aquifers and evaluates their implications for groundwater resource management in Ilorin Metropolis, Nigeria.

## Literature Review

The literature review for this study is grounded in the principles of hydrogeology focusing on the interplay between electrical resistivity, regolith aquifers, and groundwater potential.

## Concept of Regolith Aquifers

Groundwater is a critical resource especially in basement complex terrains where surface water is scarce. The geological complexity of these regions presents unique challenges and opportunities for groundwater exploration and management. Regolith aquifers are significant sources of groundwater, particularly in the basement complex terrains where they consist of weathered materials such as topsoil, clay, and fractured rock. The resistivity of these aquifers is influenced by several factors including lithology, moisture content, porosity, and the presence of electrolytes in pore fluids. In the context of Nigeria, studies have shown that groundwater in basement complex terrains is predominantly stored in regolith aquifers, which consist of weathered overburden materials such as topsoil, clay, saprolite, and fractured basement rock (Aweda et al., 2022; Igboama et al., 2024). The productivity of these aquifers is influenced by factors such as the thickness of the weathered layer, degree of weathering, and the connectivity of pore spaces. Falade *et al* (2025) observed that thicker, more weathered layers tend to exhibit higher groundwater yields, confirming the hydrogeological significance of regolith formations.

## Electrical Resistivity Methods in Nigeria

Electrical resistivity techniques, including Vertical Electrical Sounding (VES) and Electrical Resistivity Tomography (ERT), have been extensively applied in Nigeria to delineate subsurface layers and assess groundwater potential. Nwachukwu et al. (2019) highlighted the effectiveness of resistivity surveys in identifying groundwater-bearing zones in Delta State. Their findings indicated that moderate resistivity values are associated with saturated and productive aquifers, while high resistivity values correspond to fresh basement rock with low groundwater potential. This aligns with the theoretical framework established by Archie's Law, which connects resistivity with porosity and fluid saturation, thereby validating the use of resistivity data in hydrogeological studies. Aweda et al. (2022) demonstrated the application of resistivity methods in the Bida Basin, where they identified aquifer zones associated with intermediate resistivity values and significant thickness. Their findings showed that groundwater occurrence is largely controlled by weathered and fractured basement zones. Similarly, Inim et al. (2020) utilized resistivity techniques to monitor seawater intrusion in coastal aquifers, revealing that low resistivity anomalies indicate saline water encroachment, thereby informing management practices for coastal groundwater resources.

However, one of the major challenges in using electrical resistivity for groundwater exploration is the issue of non-uniqueness. Different geological materials, such as clay and saline water zones, can exhibit similar resistivity values, complicating interpretation (Hassan & Usman, 2025). In the present study, this challenge was addressed through iterative computer-assisted curve modelling, in which resistivity values were interpreted together with the characteristics VES curve type (H, A, and Q-type) rather than in isolation. This allowed layer boundaries and lithology to be constrained by curve shape and sequence position (Table 1). This challenge necessitates the integration of resistivity data

with geological and borehole information to enhance interpretative accuracy. For instance, Bayewu et al. (2022) emphasized the importance of combining resistivity data with geological surveys to better delineate aquifer boundaries and assess vulnerability to contamination. Furthermore, in areas exposed to anthropogenic activities, the protective capacity of aquifers is a critical consideration. The protective capacity is evaluated using longitudinal conductance, which is derived from resistivity data. Igboama et al. (2024) found that clay-rich layers enhance protective capacity, while sandy or fractured layers reduce it. This finding underscores the need for comprehensive assessments of geological materials overlying aquifers to inform effective groundwater management strategies.

## Materials and Methods

### Description of the Study Area

The study area, Ilorin metropolis, and its environs is the capital city of Kwara State situated in the North-central geopolitical zone of Nigeria. It is located on latitudes  $8^{\circ}30'00''$  and  $8^{\circ}50'00''$  North of the equator and longitudes  $4^{\circ}20'00''$  and  $4^{\circ}35'00''$ E of the Greenwich meridian (Figure 1). The climate of Ilorin is characterized by wet and dry seasons. The wet season begins with the onset of rainfall in April and cessation occurs in October. Ilorin experiences a double maxima rainfall pattern with peak periods in June and September, and a dry spell in July. The dry season occurs between November and February. The mean annual rainfall for Ilorin is 1200mm (Olaniran, 2002), and the temperature ranges between  $25^{\circ}\text{C}$ -  $28^{\circ}\text{C}$  (Oyegun, 1983). The drainage network is dendritic in nature, and the geology consist of the Precambrian basement complex rocks that are neither porous nor permeable. According to the National Population Commission (2016) projection, the population of Ilorin metropolis is estimated at 1,055,500. The continuous increase in population may be because of its status as the state capital and being a centre of commercial activities, this has resulted in the continuous inflow of people into the metropolis, thereby increasing the water demand.

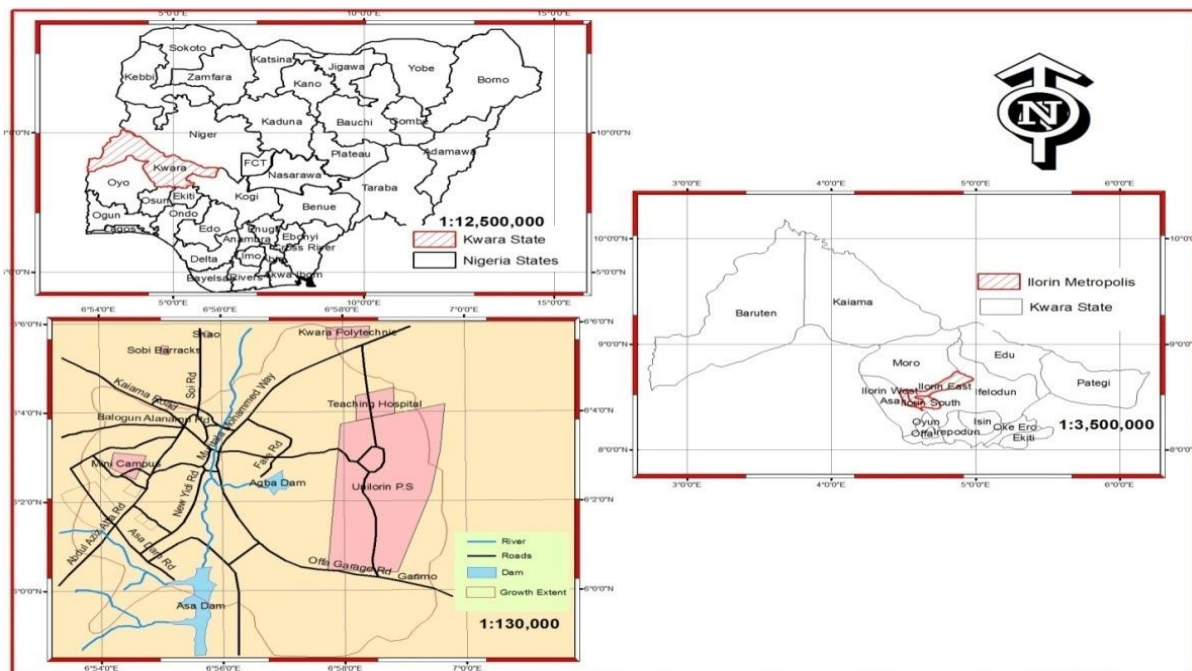


**Figure 1: Ilorin with Nigeria and Kwara State as Inset**  
Source: Adapted from Ajadi, *et al* (2016)

## Data Collection

This study adopted a quantitative geophysical research design anchored on the Vertical Electrical Sounding (VES) technique, a method widely recognized in basement complex terrains for its effectiveness in delineating subsurface lithological boundaries and assessing groundwater potential (Oyedele & Olayinka, 2012; Fawale et al., 2023; Ikuemonisan et al., 2025). Data collection followed a structured approach combining primary and secondary sources. Primary data were obtained through direct field measurements using the SAS ABEM 300C terrameter, where data such as apparent resistivity, layer thickness, depth of weathering, and number of geo-electric layers were collected at each of the 40 vertical electrical sounding stations chosen in boreholes drilled by the Lower Niger River Basin Development Authority in Ilorin metropolis. The electrode arrangement used for the soundings was that of Schlumberger where the current electrodes were spaced progressively wider at each sounding station to measure changes in resistivity with increasing depths. The geographic coordinates and elevation of each VES/borehole locations were obtained via GPS. The sampled points were located on Basement Complex rocks, providing a geologically consistent basis for comparison across the study area. Secondary data such as the borehole characteristics (e.g., static water level, and lithologic description, etc.) were sourced from the Lower Niger River Basin Development Authority, Ilorin, Kwara State records to support the spatial and geological contextualization of the primary field data.

## Data Analysis

This involved the identification of characteristics of each aquifer at the VES site. Descriptive statistical approach was used to analyse the resistivity and aquifer potential values in the 40 sites. The Mean was computed as:

$$\bar{X} = (\sum_{i=1}^n X_i) / n \dots\dots\dots (i)$$

Where:  $\bar{X}$  = the mean (average);  $X_i$  = each individual value in the dataset;  $n$  = the number of values (sample size);  $\sum_{i=1}^n$  = sum over all values from  $i = 1$  to  $n$

The Standard Deviation, used to determine how much the resistivity and aquifer values vary from the mean, was calculated as:

$$SD = \sqrt{[\sum_{i=1}^n (X_i - \bar{X})^2 / (n - 1)]} \dots\dots\dots (ii)$$

Where:  $X_i$  = each individual value in the dataset;  $\bar{X}$  = the mean of all values;  $n$  = the number of values (sample size)  $\sum_{i=1}^n$  = sum over all values from  $i = 1$  to  $n$

Also, the Coefficient of Variation used to express the relative variability of the dataset independent of its unit of measurement, was calculated as:

$$CV (\%) = (SD / \bar{X}) \times 100 \dots\dots\dots (iii)$$

Where:  $SD$  = standard deviation;  $\bar{X}$  = the mean;  $CV(\%)$  = coefficient of variation, expressed as a percentage.

Aquifer potential of each VES location was also assessed based on the conventional classification method proposed by Oyedele and Olayinka (2012), where potential ratings are assigned depending

on the resistivity values of the regolith under study, ranging from no potential ( $>300 \Omega\text{m}$ ) to best aquifer potential ( $20\text{--}100 \Omega\text{m}$ ). Frequency analysis was then carried out to ascertain the relative proportion of different types of aquifer potential in the entire study area. Visual representation of the spatial distribution of resistivity, depth of weathering, and aquifer potential in the metropolis was carried out using 1-D resistivity profile, 2-D contour maps, and frequency charts.

Inferential statistics methods, which include Pearson correlation and linear regression analysis, were used to establish the nature of the association between regolith resistivity (independent variable, X) and groundwater/aquifer potential (dependent variable, Y). Computation of the Pearson correlation coefficient was done based on:

$$r = [n \Sigma XY - (\Sigma X)(\Sigma Y)] / \sqrt{\{ [n \Sigma X^2 - (\Sigma X)^2][n \Sigma Y^2 - (\Sigma Y)^2] \}} \dots\dots\dots(\text{iv})$$

Where:  $r$  = Pearson correlation coefficient;  $n$  = number of paired observations;  $X$ ,  $Y$  = the two variables being correlated;  $\Sigma XY$  = sum of the products of each paired  $X$  and  $Y$  value;  $\Sigma X$ ,  $\Sigma Y$  = sums of  $X$  values and  $Y$  values respectively;  $\Sigma X^2$ ,  $\Sigma Y^2$  = sums of the squared  $X$  values and squared  $Y$  values respectively with  $r$  value close to  $+1$  or  $-1$  showing a strong direct relationship or inverse relationship, respectively, while a value close to  $0$  shows a weak or negligible relationship.

In predicting aquifer potential from resistivity values using the linear regression model, we have:

$$Y = a - bX \dots\dots\dots(\text{v})$$

where the regression constant ( $aa$   $a$ ) and coefficient ( $bb$   $b$ ) were calculated by the least squares method to give the following equation:

$$\text{Groundwater Potential} = 9.040 - (0.010) \times \text{Regolith Resistivity}$$

The adoption of descriptive statistics and regression models provided an opportunity to describe the resistivity pattern that existed in the study area and determine the extent to which resistivity values could statistically predict aquifer potential. The possible existence of a non-linear relationship between the variables was tested using quadratic regression modelling (see Results, Figure 7). In order to reduce the effect of resistivity ambiguity (non-uniqueness) during interpretation, VES data were processed through iterative computer-assisted curve modelling, in which layer resistivity and thickness were constrained jointly by the shape of the sounding curve ( $H$ ,  $A$ , and  $Q$ -type classifications) and by the expected sequence of regolith lithology (topsoil–laterite–weathered basement–fresh basement), rather than by resistivity value alone.

## Results and Discussion

### Log Characteristics of Regolith Rocks

Based on the resistivity logging features from the 40 vertical electrical sounding (VES) sites, Figures 2 and 3 showed the presence of a heterogeneous geological structure, which is made up mainly of  $H$ -type curves, which appeared at 9 out of 40 sites (22.5%). The areas include Egbejila, Eruda, Bada, Alanamu, Gaa Akanbi, Oja Tuntun, Isale Kannike, Sapati, and Reke. The number of  $A$ -type curves was 3, this accounted for (7.5%), appearing at Olunlade, Mubo, and Oloje sites, while the  $Q$ -type curve appeared only once (2.5%) at the Bolanta area.

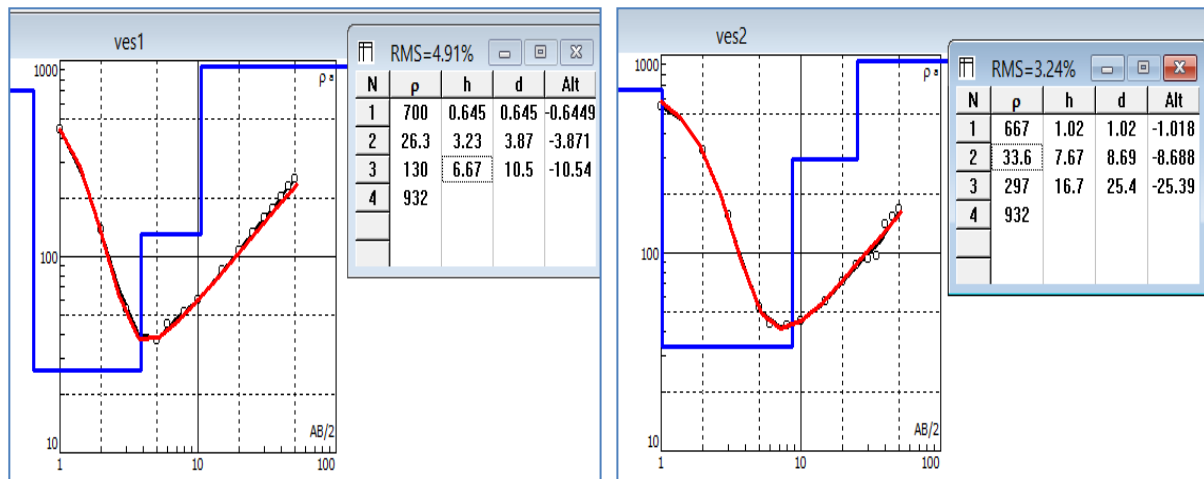


**Figure 2: The 1D Profiles Generated from Inversion of the Resistivity Data Egbejila (VES1 and 2)**  
**Source: Source: Authors Fieldwork (2026)**

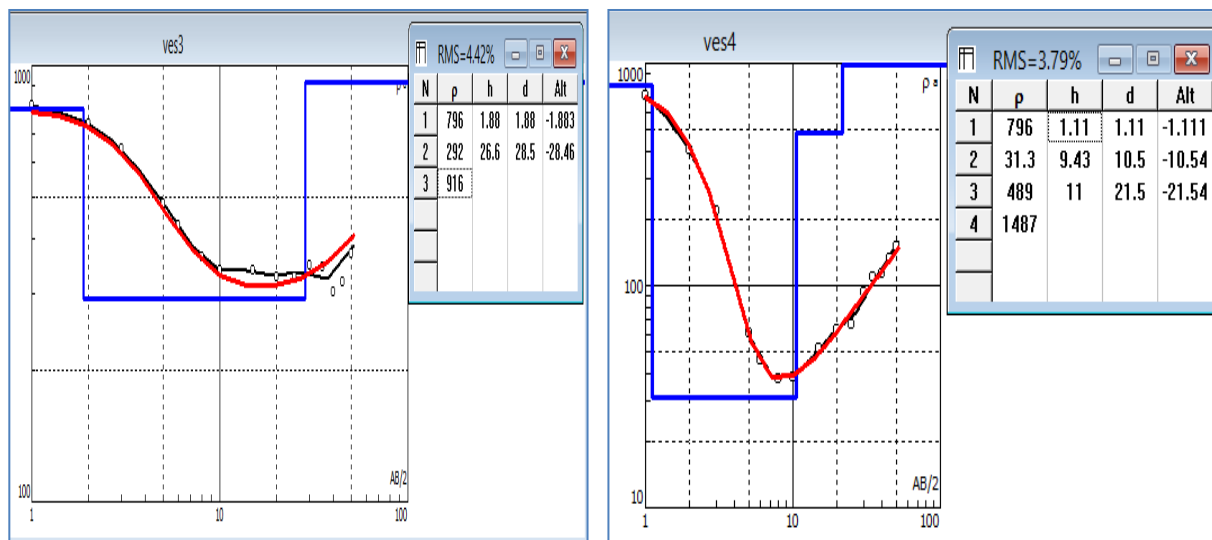


**Figure 3: The 1D Profiles Generated from Inversion of the Resistivity Data Kilanko (VES3) and Awe (VES4)**

**Source: Source: Authors Fieldwork (2026)**

### Pattern of Electrical Resistance

The computer iterations of the resistivity values are shown in Table 1, the result indicated that there were 3 to 5 different layers of geo-electrical properties in the area under investigation. The presence of three layers (laterite, weathered basement, and fresh basement) were observed to be dominant and found at 14 sites (35%) in places such as Kilanko (VES3), Awe (VES4), Olunlade (VES5), Sabo-Oke1 (VES6), Mubo1 (VES7), Sapatil (VES16), Oloje 2 (VES21), Mubo2 (VES25), Gaa Akanbi and Bolanta (VES28-30), Sapatil4, Reke, Okekere, Ode Sarumi, and Fate (VES36-40). A much more complicated structure of five layers, characterized by a different clayey layer, was observed in only 4 stations (10%). These places are Eruda (VES10), Oloje1 (VES20), Ita Elepa (VES34), and Ita Adu (VES35).

Table 1: Computer Iteration of Resistivity Data

| Location      | VES STATION | No. of Layers | Resistivity ( $\Omega m$ ) |          |                        |                    |                |
|---------------|-------------|---------------|----------------------------|----------|------------------------|--------------------|----------------|
|               |             |               | Top Soil                   | Laterite | Clayey Sand/Sandy Clay | Weathered Basement | Fresh Basement |
| Egbejila1     | VES1        | 4             | 700                        | 26.3     | —                      | 130                | 932            |
| Egbejila2     | VES2        | 4             | 667                        | 33.6     | —                      | 297                | 932            |
| Kilanko       | VES3        | 3             | —                          | 796      | —                      | 292                | 916            |
| Awe           | VES4        | 4             | 796                        | 31.3     | —                      | 489                | 1487           |
| Olunlade      | VES5        | 3             | —                          | 16.1     | —                      | 161                | 916            |
| Sabo-Oke1     | VES6        | 3             | —                          | 148      | —                      | 59                 | 932            |
| Mubo1         | VES7        | 3             | —                          | 4.23     | —                      | 18.4               | 359            |
| Sabo-Oke2     | VES8        | 4             | 68.5                       | 5.8      | —                      | 65.2               | 656            |
| Agric/Sango   | VES9        | 4             | 23.3                       | 173      | —                      | 25.5               | 684            |
| Eruda         | VES10       | 5             | 21.8                       | 1.61     | 7.14                   | 21.8               | 1400           |
| Surulere      | VES11       | 4             | 33                         | 5.38     | —                      | 33.3               | 567            |
| Asa DAm       | VES12       | 4             | 397                        | 916      | —                      | 41.5               | 965            |
| Tanke1        | VES13       | 4             | 252                        | 2346     | —                      | 55.5               | 932            |
| Tanke2        | VES14       | 4             | 41.9                       | 1401     | —                      | 17.9               | 1694           |
| Gerewu        | VES15       | 4             | 590                        | 2584     | —                      | 11.3               | 1665           |
| Sapati1       | VES16       | 3             | —                          | 49.7     | —                      | 11.1               | 2167           |
| Sapati2       | VES17       | 4             | 284                        | 564      | —                      | 54.2               | 206            |
| Sapati3       | VES18       | 4             | 198                        | 1119     | —                      | 38                 | 839            |
| Okelele       | VES19       | 4             | 34.2                       | 84.6     | —                      | 14                 | 121            |
| Oloje1        | VES20       | 5             | 79.6                       | 10.4     | 100                    | 14.6               | 130            |
| Oloje2        | VES21       | 3             | —                          | 9.23     | —                      | 6.11               | 102            |
| Sabo-Oke3     | VES22       | 4             | 74                         | 5.06     | —                      | 81                 | 394            |
| Bada          | VES23       | 4             | 3.7                        | 1.6      | —                      | 3.57               | 330            |
| Alanamu       | VES24       | 4             | 72.8                       | 8.55     | —                      | 18.7               | 183            |
| Mubo2         | VES25       | 3             | —                          | 5.31     | —                      | 30                 | 123            |
| Danialu1      | VES26       | 4             | 276                        | 1255     | —                      | 110                | 1130           |
| Danialu2      | VES27       | 4             | 308                        | 933      | —                      | 101                | 949            |
| GaaAkanbi1    | VES28       | 3             | —                          | 122      | —                      | 42.2               | 109            |
| GaaAkanbi2    | VES29       | 3             | —                          | 50.6     | —                      | 22.1               | 1110           |
| Bolanta       | VES30       | 3             | —                          | 34.7     | —                      | 20.7               | 13.4           |
| JalalaVillage | VES31       | 4             | 188                        | 297      | —                      | 140                | 748            |
| Oja Tuntun    | VES32       | 4             | 136                        | 7.98     | —                      | 18.9               | 198            |
| Isale Kannike | VES33       | 4             | 45.2                       | 51.2     | —                      | 22.6               | 70             |
| Ita Elepa     | VES34       | 5             | 254                        | 34.4     | 87.9                   | 13                 | 949            |
| Ita Adu       | VES35       | 5             | 232                        | 26.3     | 76.8                   | 13.7               | 945            |
| Sapati4       | VES36       | 3             | —                          | 134      | —                      | 77.3               | 2165           |
| Reke          | VES37       | 3             | —                          | 89.8     | —                      | 32.9               | 1786           |
| Okekere       | VES38       | 3             | —                          | 105      | —                      | 16.9               | 234            |
| Ode Sarumi    | VES39       | 3             | —                          | 105      | —                      | 14                 | 234            |
| Fate          | VES40       | 3             | —                          | 99.1     | —                      | 12                 | 234            |

Source: Authors Fieldwork (2026)

This diversity in curve types and number of layers clearly suggests high lateral variability of subsurface lithology, implying that the basement complex geology under Ilorin metropolis is not homogeneously weathered, but rather characterized by specific geological history and basement weathering degree. The predominance of H-type curves in nine stations together with A and Q-type curves clearly positions Ilorin metropolis in the category of a resistivity profile typical for Nigerian basement complex regions. Ikuemonisan et al. (2025) similarly reported dominant KH/HA-type curves and three-to-five-layer earth models in a comparable basement complex terrain. The significance of the above observation to the study area of Ilorin is that the regolith in the area has experienced the two stages of weathering and lateritization common to basement complex rocks, resulting in a stratified regolith with the second or third layer being the water bearing layer.

### Pattern of Electrical Resistance in the Rocks of the Study Area

The resistivity profile through the geological zones reflect that resistivity values tend to increase with depth, starting from the topsoil to the fresh basement, albeit with significant lateral variation (Table 1). The topsoil zone recorded the highest variability in resistivity, having a minimum of 3.7  $\Omega\text{m}$  at Bada (VES23) and maximum of 796  $\Omega\text{m}$  at Kilanko (VES3 - Laterite Value) and Awe (VES4 - Topsoil Value), which is over 200 times variation in resistivity that depends on the moisture content, compactness, and material type at the surface. The regolith aquifer represented by weathered basement recorded the resistivity between 3.57  $\Omega\text{m}$  at Bada (VES23) and 297  $\Omega\text{m}$  at Egbejila2 (VES2). This is highly significant, as this is where the major underground water source occurs in the study area. Furthermore, figure 4 revealed that most stations fall far below 150  $\Omega\text{m}$ , with resistivities of 6.11  $\Omega\text{m}$  (Oloje2), 11.1  $\Omega\text{m}$  (Sapati1), 14  $\Omega\text{m}$  (Okelele, Ode Sarumi), 18.4-22.6  $\Omega\text{m}$  (others). The new basement had the highest and varied resistivity readings, ranging between 70  $\Omega\text{m}$  at Isale Kannike (VES33) and 2167  $\Omega\text{m}$  at Sapati1 (VES16) – thirty times different.

The spatial variation of resistivity in the regolith (Figure 5) indicates that there is high resistivity in the south-western part of the study area, especially in the Egbejila (130-297  $\Omega\text{m}$ ) and Asa Dam areas (41.5  $\Omega\text{m}$ ), while low resistivity values dominate the north-western and south-eastern parts of the study area, especially in Gerewu (11.3  $\Omega\text{m}$ ) and Sapati (11.1-77.3  $\Omega\text{m}$ ), with the north-eastern Danialu area (101-110  $\Omega\text{m}$ ) having intermediate values of resistivity. The spatial variations imply that there is systematic variation in the extent of weathering, fracturing, and saturation of the regolith within the metropolis.

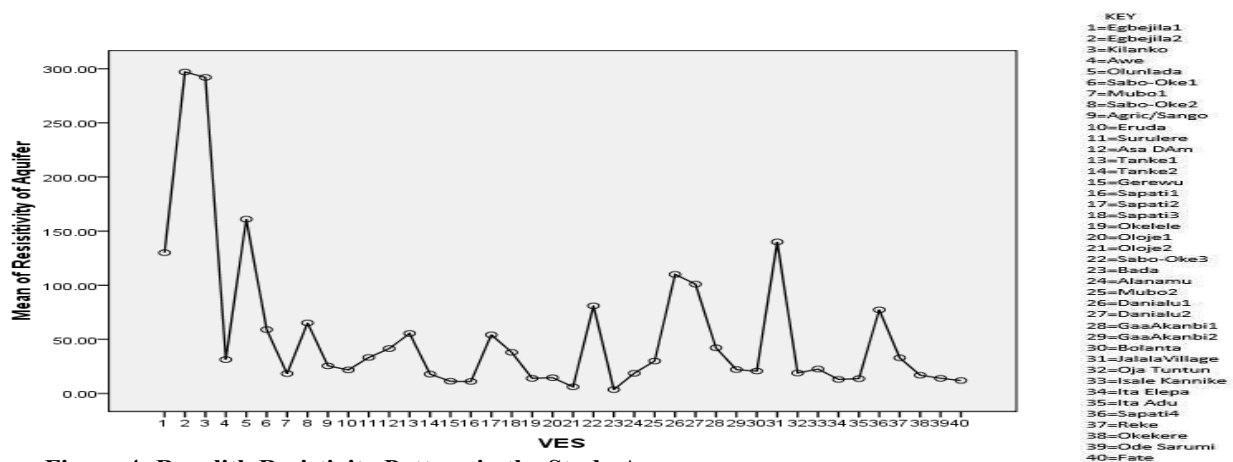


Figure 4: Regolith Resistivity Pattern in the Study Area

Source: Authors Fieldwork (2026)

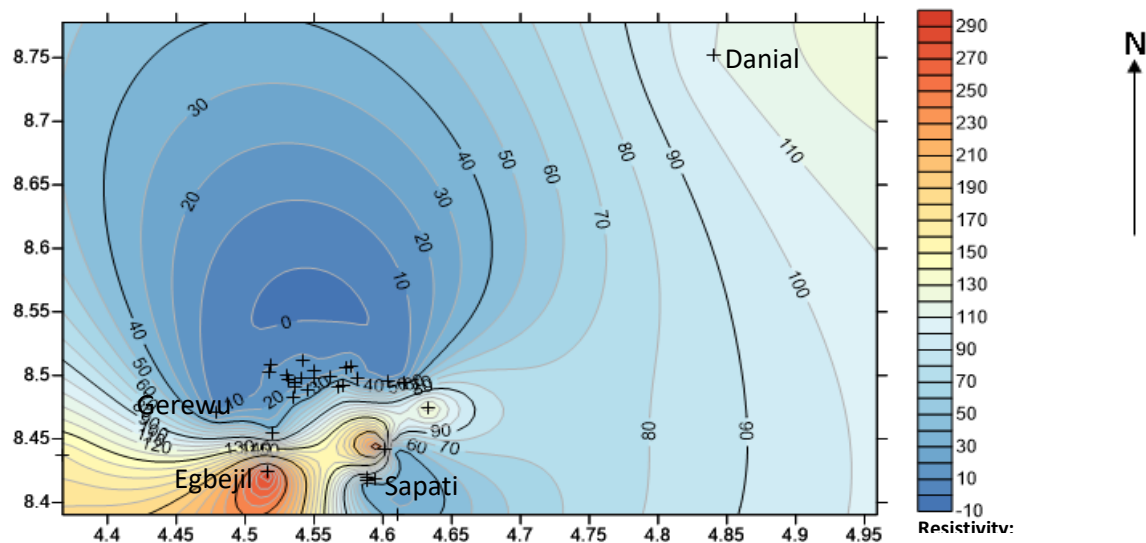


**Figure 5: Contoured Map of Regolith Resistivity Pattern in the Study Area**

Source: Authors' Fieldwork (2026)

The broad resistivity range of 3.57 – 297  $\Omega\text{m}$  in the regolith aquifer layer may be linked to variations in weathering processes and clay minerals in Ilorin, a trend that is consistent with findings from a VES study by Fawale *et al.*, (2023) at Oke-Adini, Ilorin metropolis, where resistivity in weathered basement rocks ranged between 54 and 150  $\Omega\text{m}$  while fractured basement rocks exhibited even wider variation in resistivity ranging from 6 to greater than 500  $\Omega\text{m}$ . In a related study conducted in Kuje District, Abuja by Ikuemonisan *et al.*, (2025), the resistivity of weathered and fractured basement rocks in the study area was found to be between 38 and greater than 2,400  $\Omega\text{m}$ , which may be attributed to variation in weathering intensity and the varying amount of clay and moisture in the area. Hence, the study revealed that there is clustering of high resistivity values near Egbejila/Asa Dam area, while low resistivity values cluster near Gerewu and Sapati areas, implying that groundwater exploration must consider the resistivity variation of each location in Ilorin as opposed to the general assumption about quality of the aquifer because basement complex aquifers in Nigeria are discontinuous and laterally variant due to weathering and structural controls.

### Estimate of Weathering Depth

The degree of weathering (or overburden depth) as shown in Tables 2 and 3 and Figures 4 and 5 varied widely among the 40 VES stations studied, ranging from the lowest of 3.30 m at Oloje 2 (VES21) to the highest of 31.28 m at Oja Tuntun (VES32). The high variation in the vertical extent of weathering is demonstrated by a number of stations which had very low weathering depths below 5m, namely Olunlade (3.37 m), Mubo 1 (6.13 m) and Tanke 2 (3.67 m), while a few other stations had very high weathering depths of over 25m, namely Kilanko (28.48 m), Sabo-Oke 3 (26.34 m), Egbejila 2 (25.39 m) and Danialu 1 (25.16 m) besides the highest weathering depth at Oja Tuntun. This large variation is vital since in hard rock regions, water bearing boreholes normally require adequate thickness of weathered and fractured basement in order to accommodate reasonable quantity of groundwater. Previous literature Oyedele and Olayinka (2012) suggested that overburden thickness of 20 to 30 m

would be the minimum threshold for water extraction purposes; using this standard, about 8 out of the 40 stations (20%) satisfy the criterion.

As seen from the contoured map of the weathering depth in space (Figure 5), it can be concluded that the most weathered areas are found in the north-eastern and south-western parts of the study area, and, thus, thicker sections of saturated regolith are possible in these zones; on the contrary, those sites with lesser weathering depths, like Oloje 2 (3.30 m) and Olunlade (3.37 m), are less likely to have any storage capacity for underground water, and therefore require further investigation before being considered for borehole development.

**Table 2: Thicknesses of Layers and Depth of Weathering obtained from Resistivity Data**

| Location    | VES STATION | No. of Layers | Thickness (m) |          |                        | Weathered Basement | Fresh Basement | Depth of Weathering |
|-------------|-------------|---------------|---------------|----------|------------------------|--------------------|----------------|---------------------|
|             |             |               | Top Soil      | Laterite | Clayey Sand/Sandy Clay |                    |                |                     |
| Egbejila1   | VES1        | 4             | 0.645         | 3.23     | —                      | 6.67               | —              | 10.55               |
| Egbejila2   | VES2        | 4             | 1.02          | 7.67     | —                      | 16.7               | —              | 25.39               |
| Kilanko     | VES3        | 3             | —             | 1.88     | —                      | 26.6               | —              | 28.48               |
| Awe         | VES4        | 4             | 1.11          | 9.43     | —                      | 11                 | —              | 21.54               |
| Olunlada    | VES5        | 3             | —             | 0.768    | —                      | 2.6                | —              | 3.37                |
| Sabo-Oke1   | VES6        | 3             | —             | 2.21     | —                      | 6.33               | —              | 8.54                |
| Mubo1       | VES7        | 3             | —             | 0.597    | —                      | 5.53               | —              | 6.13                |
| Sabo-Oke2   | VES8        | 4             | 0.762         | 1.29     | —                      | 12.2               | —              | 14.25               |
| Agric/Sango | VES9        | 4             | 1.06          | 6.11     | —                      | 15.7               | —              | 22.87               |
| Eruda       | VES10       | 5             | 0.689         | 2.2      | 4.25                   | 12.5               | —              | 19.64               |
| Surulere    | VES11       | 4             | 0.642         | 2.41     | —                      | 4.58               | —              | 7.63                |
| Asa Dam     | VES12       | 4             | 1.05          | 0.649    | —                      | 11.3               | —              | 13.00               |
| Tanke1      | VES13       | 4             | 1.319         | 3.09     | —                      | 13.6               | —              | 18.01               |
| Tanke2      | VES14       | 4             | 0.495         | 0.744    | —                      | 2.43               | —              | 3.67                |
| Gerewu      | VES15       | 4             | 0.983         | 0.725    | —                      | 3.7                | —              | 5.41                |
| Sapati1     | VES16       | 3             | —             | 0.81     | —                      | 2.8                | —              | 3.61                |
| Sapati2     | VES17       | 4             | 0.843         | 4.86     | —                      | 7                  | —              | 12.70               |
| Sapati3     | VES18       | 4             | 0.5           | 0.757    | —                      | 8.4                | —              | 9.66                |
| Okelele     | VES19       | 4             | 1.49          | 2.74     | —                      | 15.6               | —              | 19.83               |
| Oloje1      | VES20       | 5             | 0.939         | 0.941    | 4.68                   | 10.1               | —              | 16.66               |
| Oloje2      | VES21       | 3             | —             | 0.973    | —                      | 2.33               | —              | 3.30                |
| Sabo-Oke3   | VES22       | 4             | 0.715         | 0.921    | —                      | 24.7               | —              | 26.34               |
| Bada        | VES23       | 4             | 0.949         | 1.21     | —                      | 15.9               | —              | 18.06               |

**Source: Authors' Fieldwork (2026)**

Overburden thickness within the study area (3.30 m at Oloje 2 to 31.28 m at Oja Tuntun) lies predominantly below the threshold believed to be required for productive drilling in basement complex regions. This is supported by a study conducted in the Oke-Adini area (Ilorin), in which the thickness of the weathered basement varied from 2 to 17 m at twelve VES points, and only points

with the least resistivity values and overburden thicknesses were chosen as potential sites for borehole drilling (Fawale et al., 2023).

This implies that the overburden thickness and not merely resistivity appears to be an important limiting criterion for sustainable borehole yield throughout most of Ilorin city due to the very few stations (such as Kilanko, Oja Tuntun, Sabo-Oke 3, Egbejila 2, Danialu 1) having optimal threshold of 20-30 m (Table 3). This observation corroborates the general observation regarding the basement complex that weathered and fractured basement thicknesses have wide variations in even small-sized survey areas and determines the possibility of drilling a sustainable borehole, as indicated in the case of Kuje District where principal aquifer thickness varied from 3 to 52 m (Ikueomonisan et al., 2025). The practical inference is that resistivity favourable stations in Ilorin need to be examined against minimum overburden thickness before proceeding to borehole siting, considering the low yields or failures reported in thin-regolith regions of the basement terrain.

**Table 3: Thicknesses of Layers and Depth of Weathering obtained from Resistivity Data**

| Location      | VES STATION | No. of Layers | Thickness (m) |          |                        | Weathered Basement | Fresh Basement | Depth of Weathering |
|---------------|-------------|---------------|---------------|----------|------------------------|--------------------|----------------|---------------------|
|               |             |               | Top Soil      | Laterite | Clayey Sand/Sandy Clay |                    |                |                     |
| Alanamu       |             |               | 0.68          |          |                        |                    |                | 18.73               |
| VES24         | 4           | 1             | 3.65          | —        | 14.4                   | —                  |                |                     |
| Mubo2         | VES25       | 3             | —             | 1.13     | —                      | 3.85               | —              | 4.98                |
| Danialu1      | VES26       | 4             | 0.68          | 2.67     | 21.8                   | —                  | —              | 25.16               |
|               |             |               | 7             |          |                        |                    |                |                     |
| Danialu2      | VES27       | 4             | 1.02          | 1.73     | 17                     | —                  | —              | 19.75               |
| GaaAkanbil    | VES28       | 3             | —             | 0.699    | —                      | 17.1               | —              | 17.80               |
| GaaAkanbi2    | VES29       | 3             | —             | 0.515    | —                      | 14.9               | —              | 15.42               |
| Bolanta       | VES30       | 3             | —             | 1.82     | —                      | 22                 | —              | 23.82               |
| JalalaVillage | VES31       | 4             |               |          |                        |                    |                | 11.51               |
|               |             |               | 0.78          | 1.05     | —                      | 9.68               | —              |                     |
| Oja Tuntun    | VES32       | 4             | 0.5           | 1.48     | —                      | 29.3               | —              | 31.28               |
| Isale         | VES33       | 4             | 0.64          |          |                        |                    |                | 20.38               |
|               |             |               | 5             | 0.839    | —                      | 18.9               | —              |                     |
| Kannike       | VES34       | 5             | 0.5           | 1.11     | 3.6                    | 11.6               | —              | 16.81               |
| Ita Elepa     | VES35       | 5             | 0.46          |          |                        |                    |                | 22.48               |
|               |             |               | 1             | 1.45     | 2.57                   | 18                 | —              |                     |
| Ita Adu       | VES36       | 3             | —             | 1.67     | —                      | 9.78               | —              | 11.45               |
| Sapati4       | VES37       | 3             | —             | 1.65     | —                      | 5.47               | —              | 7.12                |
| Reke          | VES38       | 3             | —             | 3.44     | —                      | 11.5               | —              | 14.94               |
| Odekere       |             |               |               |          |                        |                    |                | 14.98               |
| Ode           |             |               |               |          |                        |                    |                |                     |
| Sarumi        | VES39       | 3             | —             | 3.28     | —                      | 11.7               | —              |                     |
| Fate          | VES40       | 3             | —             | 3.51     | —                      | 11.7               | —              | 15.21               |

Source: Authors Fieldwork (2026)

### Implication of the Recorded Electrical Resistance to Water Resource Development in Ilorin Metropolis

Aquifer potential was statistically evaluated by applying the resistivity classification scheme presented in Table 4 to the regolith resistivity values obtained at each station, as shown in Table 5. The result revealed that the majority of the study area, specifically 18 of 40 stations (45%), falls within the "optimum weathering and groundwater potential" category (aquifer potential value of 10.5, corresponding to resistivity between 20–100  $\Omega\text{m}$ ).

**Table 4: Aquifer Potential as a Function of Regolith Resistivity**

| Regolith Resistivity ( $\Omega\text{-m}$ ) | Aquifer characteristics                      | Aquifer Potential ( $\Omega\text{-m}$ ) |
|--------------------------------------------|----------------------------------------------|-----------------------------------------|
| <20                                        | Clayey; limited aquifer potential            | 7.0                                     |
|                                            | Optimum weathering and groundwater potential |                                         |
| 20-100                                     | Medium aquifer conditions and potential      | 10.5                                    |
|                                            | Limited weathering and poor potential        |                                         |
| 100-150                                    | Optimum weathering and groundwater potential | 7.5                                     |
|                                            | Medium aquifer conditions and potential      |                                         |
| 150-300                                    | Limited weathering and poor potential        | 5.0                                     |
|                                            | Optimum weathering and groundwater potential |                                         |
| >300                                       | Negligible                                   | 2.5                                     |

**Source: Oyedele and Olayinka (2012)**

#### *Dimensionless index derived from resistivity classification (Oyedele & Olayinka, 2012)*

These locations such as Awe (31.3  $\Omega\text{m}$ ), Sabo-Oke (59–81  $\Omega\text{m}$ ), Agric/Sango (25.5  $\Omega\text{m}$ ), Eruda (21.8  $\Omega\text{m}$ ), Asa Dam (41.5  $\Omega\text{m}$ ), Surulere (33.3  $\Omega\text{m}$ ), and Sapati (32.9–77.3  $\Omega\text{m}$ ), making these areas as the most promising zones for borehole siting.

In addition, the result in Table 6 and Figure 6 indicate that 15 stations (37.5%) were found to be clayey, with limited aquifer potential (resistivity < 20  $\Omega\text{m}$ , aquifer potential = 7.0) which include stations such as Mubol (18.4  $\Omega\text{m}$ ), Bada (3.57  $\Omega\text{m}$ ) and Ita Elepa (13  $\Omega\text{m}$ ). Four stations (10%) showed medium aquifer conditions and potential (aquifer potential = 7.5, resistivity 100-150  $\Omega\text{m}$ ) which include stations like Egbejila 1 (130  $\Omega\text{m}$ ), Danialu1-2 (101-110  $\Omega\text{m}$ ) and Jalala Village (140  $\Omega\text{m}$ ). Three stations (7.5%) belonged to limited weathering and poor potential (aquifer potential = 5.0, resistivity 150-300  $\Omega\text{m}$ ) which include stations such as Egbejila 2 (297  $\Omega\text{m}$ ), Kilanko (292  $\Omega\text{m}$ ) and Olunlade (161  $\Omega\text{m}$ ). Surprisingly, none of the stations was found to be negligible (resistivity > 300  $\Omega\text{m}$ , aquifer potential = 2.5).

Table 5: Aquifer Potential and Characteristics

| S/N | Location      | VES LABEL | Aquifer Resistivity ( $\Omega$ -m) | Aquifer Potential (Index Value) | Aquifer characteristics                      |
|-----|---------------|-----------|------------------------------------|---------------------------------|----------------------------------------------|
| 1   | Egbejila1     | VES1      | 130                                | 7.5                             | Medium aquifer conditions and potential      |
| 2   | Egbejila2     | VES2      | 297                                | 5.0                             | Limited weathering and poor potential        |
| 3   | Kilanko       | VES3      | 292                                | 5.0                             | Limited weathering and poor potential        |
| 4   | Awe           | VES4      | 31.3                               | 10.5                            | Optimum weathering and groundwater potential |
| 5   | Olunlade      | VES5      | 161                                | 5.0                             | Limited weathering and poor potential        |
| 6   | Sabo-Oke1     | VES6      | 59                                 | 10.5                            | Optimum weathering and groundwater potential |
| 7   | Mubo1         | VES7      | 18.4                               | 7.0                             | Clayey; limited aquifer potential            |
| 8   | Sabo-Oke2     | VES8      | 65.2                               | 10.5                            | Optimum weathering and groundwater potential |
| 9   | Agric/Sango   | VES9      | 25.5                               | 10.5                            | Optimum weathering and groundwater potential |
| 10  | Eruda         | VES10     | 21.8                               | 10.5                            | Optimum weathering and groundwater potential |
| 11  | Surulere      | VES11     | 33.3                               | 10.5                            | Optimum weathering and groundwater potential |
| 12  | Asa DAm       | VES12     | 41.5                               | 10.5                            | Optimum weathering and groundwater potential |
| 13  | Tanke1        | VES13     | 55.5                               | 10.5                            | Optimum weathering and groundwater potential |
| 14  | Tanke2        | VES14     | 17.9                               | 7.0                             | Clayey; limited aquifer potential            |
| 15  | Gerewu        | VES15     | 11.3                               | 7.0                             | Clayey; limited aquifer potential            |
| 16  | Sapati1       | VES16     | 11.1                               | 7.0                             | Clayey; limited aquifer potential            |
| 17  | Sapati2       | VES17     | 54.2                               | 10.5                            | Optimum weathering and groundwater potential |
| 18  | Sapati3       | VES18     | 38                                 | 10.5                            | Optimum weathering and groundwater potential |
| 19  | Okelele       | VES19     | 14                                 | 7.0                             | Clayey; limited aquifer potential            |
| 20  | Oloje1        | VES20     | 14.6                               | 7.0                             | Clayey; limited aquifer potential            |
| 21  | Oloje2        | VES21     | 6.11                               | 7.0                             | Clayey; limited aquifer potential            |
| 22  | Sabo-Oke3     | VES22     | 81                                 | 10.5                            | Optimum weathering and groundwater potential |
| 23  | Bada          | VES23     | 3.57                               | 7.0                             | Clayey; limited aquifer potential            |
| 24  | Alanamu       | VES24     | 18.7                               | 7.0                             | Clayey; limited aquifer potential            |
| 25  | Mubo2         | VES25     | 30                                 | 10.5                            | Optimum weathering and groundwater potential |
| 26  | Danialu1      | VES26     | 110                                | 7.5                             | Medium aquifer conditions and potential      |
| 27  | Danialu2      | VES27     | 101                                | 7.5                             | Medium aquifer conditions and potential      |
| 28  | GaaAkanbi1    | VES28     | 42.2                               | 10.5                            | Optimum weathering and groundwater potential |
| 29  | GaaAkanbi2    | VES29     | 22.1                               | 10.5                            | Optimum weathering and groundwater potential |
| 30  | Bolanta       | VES30     | 20.7                               | 10.5                            | Optimum weathering and groundwater potential |
| 31  | JalalaVillage | VES31     | 140                                | 7.5                             | Medium aquifer conditions and potential      |
| 32  | Oja Tuntun    | VES32     | 18.9                               | 7.0                             | Clayey; limited aquifer potential            |
| 33  | Isale Kannike | VES33     | 22.6                               | 10.5                            | Optimum weathering and groundwater potential |
| 34  | Ita Elepa     | VES34     | 13                                 | 7.0                             | Clayey; limited aquifer potential            |
| 35  | Ita Adu       | VES35     | 13.7                               | 7.0                             | Clayey; limited aquifer potential            |
| 36  | Sapati4       | VES36     | 77.3                               | 10.5                            | Optimum weathering and groundwater potential |
| 37  | Reke          | VES37     | 32.9                               | 10.5                            | Optimum weathering and groundwater potential |
| 38  | Okekere       | VES38     | 16.9                               | 7.0                             | Clayey; limited aquifer potential            |
| 39  | Ode Sarumi    | VES39     | 14                                 | 7.0                             | Clayey; limited aquifer potential            |
| 40  | Fate          | VES40     | 12                                 | 7.0                             | Clayey; limited aquifer potential            |

Source: Authors' Fieldwork (2026)

Dimensionless index derived from resistivity classification (Oyedele &amp; Olayinka, 2012)

Thus, Table 6 show the mean aquifer potential of 8.4.

| Aquifer Potential | Aquifer characteristics                      | Frequency | Percent | Valid Percent |
|-------------------|----------------------------------------------|-----------|---------|---------------|
| 2.5               | Negligible                                   | -         | -       | -             |
| 5                 | Limited weathering and poor potential        | 3         | 7.5     | 7.5           |
| 7                 | Clayey; limited aquifer potential            | 15        | 37.5    | 37.5          |
| 7.5               | Medium aquifer conditions and potential      | 4         | 10.0    | 10.0          |
| 10.5              | Optimum weathering and groundwater potential | 18        | 45.0    | 45.0          |
| Total:            |                                              | 40        | 100.0   |               |

Source: Authors' Fieldwork (2026)

Dimensionless index derived from resistivity classification (Oyedele & Olayinka, 2012)

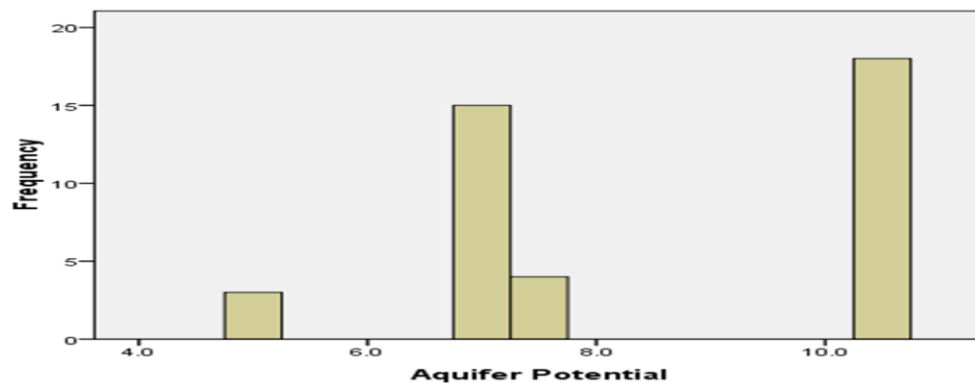


Figure 6: Frequency Chart of Aquifer Potential of the Study Area

Source: Authors' Fieldwork (2026)

Nevertheless, from the result of the correlation matrix in Table 7, suggest that a relatively poor negative association between resistivity of regolith and the potential for the formation of aquifers ( $r = -0.361$ ,  $p = 0.022$ ,  $n = 40$ ), meaning that resistivity alone is not a good indicator of ground water yields, there are other geological variables affecting the formation of groundwater like weathering and the tectonic regime after deposition, as illustrated in Table 7:

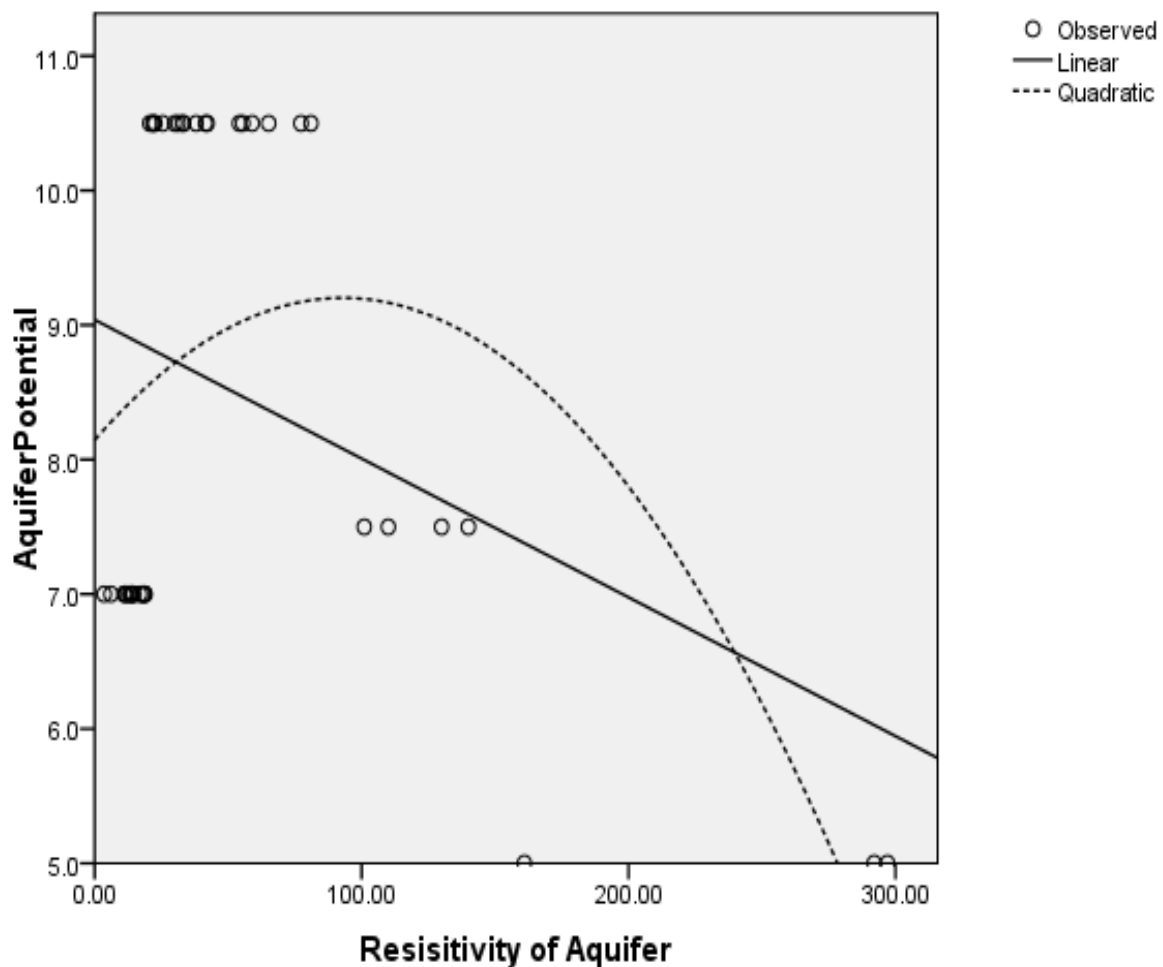
$$Y = 9.040 - 0.010_{(\text{resistivity})}$$

(constant = 9.040, SE = 0.374; resistivity coefficient = -0.010, SE = 0.004, standardized  $\beta = -0.361$ ,  $t = -2.385$ ,  $p = 0.022$ , 95% CI: -0.019 to -0.002). Therefore, the result in table 7 indicate a statistically significant yet weak inverse linear correlation. However, a better fit was provided by the quadratic non-linear regression plotted in Figure 7, where the aquifer potential increases as resistivity increases until about 100  $\Omega\text{m}$  and then starts to decrease afterward. This demonstrates the limitation of resistivity as a single predictive variable for aquifer potential in a basement complex environment. All these results indicate that the use of resistivity surveys, although very important, should be integrated with other hydrogeological factors to ensure effective utilization of groundwater resources within the city of Ilorin.

**Table: Prediction of Aquifer Potential from Regolith Resistivity**

| Analysis    | Variable(s) / Predictor                    | R     | B     | Std. Error | Beta  | T      | Sig. | 95% CI Lower | 95% CI Upper | N  |
|-------------|--------------------------------------------|-------|-------|------------|-------|--------|------|--------------|--------------|----|
| Correlation | No. of Layers & Resistivity of Aquifer     | .074  |       |            |       |        | .649 |              |              | 40 |
| Correlation | No. of Layers & Aquifer Potential          | .057  |       |            |       |        | .726 |              |              | 40 |
| Correlation | Resistivity of Aquifer & Aquifer Potential | .361* |       |            |       |        | .022 |              |              | 40 |
| Regression  | (Constant)                                 |       | 9.040 | .374       |       | 24.174 | .000 | 8.283        | 9.797        |    |
| Regression  | Resistivity of Aquifer                     |       | -.010 | .004       | -.361 | -2.385 | .022 | -.019        | -.002        |    |

Source: Authors' Fieldwork (2026)

**Figure 7: Curve Estimate/Plot of the Regression Line**

Source: Authors Fieldwork (2026)

The relatively weak and negative correlation ( $r = -0.361$ ) observed between the regolith resistivity and aquifer potential serves to emphasize the general agreement within the realm of basement complex hydro-geophysics regarding the fact that resistivity is just one of the multiple controlling factors, which include weathering thickness, fracture density, geological structure, and the nature of the aquifer itself, which influence the presence and yield of groundwater. This is evidenced in a study by Sunkari *et al.*, (2021) on hydro-geophysics of the fractured basement aquifer of the Federal Capital Territory, Abuja, where groundwater presence and flow direction were influenced not only by resistivity alone but by the interplay of fracture distribution, overburden thickness, and structural obstructions, among others.

In the same vein, findings from the Kuje District study by Ikuemonisan *et al.*, (2025) revealed that high yield zones could be observed at those locations where good resistivity is matched with good thickness and permeability of aquifers; however, other resistivity good zones exhibited no potential for groundwater development when thickness and hydraulic parameters were taken into consideration. This methodology having been locally proven within the Oke-Adini area of Ilorin through identification of the most desirable drilling sites in terms of a combination of low resistivity and high overburden thickness (Fawale *et al.*, 2023). As far as implementation goes, this means that future groundwater development should focus on regions where there are good resistivity values (20–100  $\Omega\text{m}$  - optimum class) together with overburden thickness of about 20 m or more (Sabo-Oke 3, Egbejila) and avoid zones of extremely low and high resistivity values irrespective of their classifications on the aquifer potential scale.

### Conclusion and Recommendations

This study aimed to examine the pattern of electrical resistivity in the regolith aquifer of Ilorin metropolis and its implications for groundwater management. The results revealed that regolith resistivity is highly variable (3.57–297  $\Omega\text{m}$ ) and spatially controlled, with high values in the south-western areas (Egbejila, Asa Dam) and low values in the north-western and south-eastern areas (Gerewu, Sapati), corresponding to differences in weathering depth (3.30–31.28 m) across the metropolis. While 45% of the study area displayed high aquifer potential, the weak correlation between resistivity and aquifer potential ( $r = -0.361$ ) indicates that resistivity alone is not sufficient determinant of groundwater yield and should be interpreted alongside overburden thickness and other hydrogeological factors. This limitation implies that future studies should incorporate additional variables, such as hydraulic/pumping test parameters and lithological data from boreholes, to improve the predictive reliability of aquifer potential assessments in the study area.

For groundwater management in Ilorin, borehole siting should prioritize zones with both favourable resistivity (20–100  $\Omega\text{m}$ ) and adequate overburden thickness, including Awe, Sabo-Oke, Surulere, Agric/Sango, Tanke, Mubo, Gaa Akanbi, Bolanta, Isale Kannike, Sapati, and Reke, while clayey, low-potential zones such as Bada and Oloje should be avoided or further investigated. Therefore, Vertical Electrical Sounding is recommended as a compulsory pre-drilling assessment for sustainable groundwater development in Ilorin and similar basement complex terrains.

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