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Interpretation Of Resistivity Attributes for Groundwater Prospecting in Abuja Campus, University of Port Harcourt.

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Abstract
Groundwater remains the most reliable water source in the Niger Delta, where surface water is vulnerable to anthropogenic contamination and saline intrusion. This study characterizes aquifer units within the Benin Formation at the Abuja Campus of the University of Port Harcourt using Vertical Electrical Sounding (VES) and Electrical Resistivity Tomography (ERT). VES data from analog terrameters revealed a five-layer subsurface sequence with a QH-type curve, dominated by alternating clay and sand units. A thick sandy aquifer with resistivity of ~575.57 Ωm at ~25 m depth, and a deeper sandy aquifer with ~718.30 Ωm resistivity, were delineated. The ERT results complemented these findings by providing lateral continuity of freshwater-bearing zones, strengthening aquifer delineation. Integration of both datasets confirms the presence of confined and semi-confined aquifers, suitable for sustainable groundwater exploitation. This research demonstrates that integrating resistivity techniques enhances aquifer mapping in sedimentary terrains.
Keywords: *Benin Formation, groundwater, aquifer, resistivity, VES, ERT, University of Port Harcourt*

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I. Introduction

Groundwater constitutes a critical resource for domestic, agricultural, and industrial activities in Nigeria, particularly in the Niger Delta, where surface water bodies are frequently compromised by oil pollution, industrial discharges, and saline intrusion (Obianyo et al., 2020). At the University of Port Harcourt, Abuja Campus, water demand has intensified due to the rapidly expanding student population exceeding 35,000 (Tamunobereton-Ari et al., 2021). While groundwater provides a dependable alternative, borehole failures are common due to the heterogeneity of the Benin Formation, which consists of unconsolidated sands intercalated with clay lenses (Ekanem et al., 2020). Accurate aquifer delineation is therefore vital for effective groundwater resource management on the campus.

The Benin Formation, the principal aquifer system in the region, is renowned for its high porosity and permeability, making it favorable for groundwater storage (Ekwe et al., 2023). However, its heterogeneous stratigraphy complicates subsurface characterization, particularly in urban environments where infrastructural noise interferes with geophysical surveys. Previous studies have successfully applied Vertical Electrical Sounding (VES) and Electrical Resistivity Tomography (ERT) to characterize aquifers in similar terrains (Aizebeokhai et al., 2022; Ishola et al., 2023). VES provides detailed vertical resolution of lithological units, while ERT offers two-dimensional imaging of lateral variations. However, very few studies have integrated both techniques specifically within the Abuja Campus of the University of Port Harcourt.

This study addresses this gap by applying integrated VES and ERT surveys to delineate aquifer units and evaluate their hydrogeological potential. By identifying both shallow and deep aquifers, and highlighting confining clay layers, the research not only advances scientific understanding of the Benin Formation but also provides practical recommendations for groundwater development on the campus.

Study Area

The study was conducted at the Abuja Campus of the University of Port Harcourt, located within Choba in Obio-Akpor Local Government Area, Rivers State, Nigeria. Geographically, the campus lies between latitudes 4°53′14″–4°54′42″ N and longitudes 6°54′00″–6°55′50″ E. The terrain is part of the Niger Delta sedimentary basin, underlain by the Benin Formation, a sequence of unconsolidated sands with interbedded clay and lateritic materials (Avbovbo, 1978; Reijers, 1996). The area experiences a humid tropical climate, with annual rainfall exceeding 2,500 mm, which supports shallow and semi-confined aquifers (Amajor, 1991). Rapid urbanization and campus infrastructural growth have heightened the need for sustainable groundwater exploration.

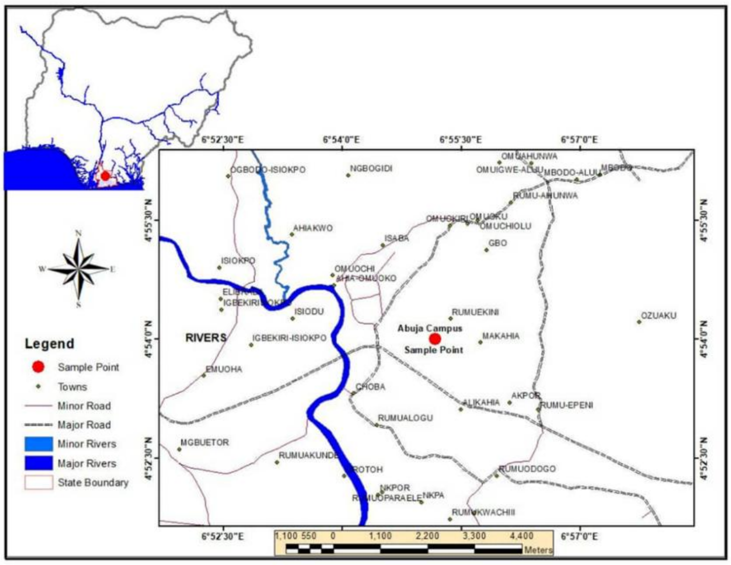

Figure 1: Map of Study Area.

II. Materials and Method

Data were acquired using both analog and digital terrameter systems to perform Vertical Electrical Sounding (VES) and Electrical Resistivity Tomography (ERT). For VES, the Schlumberger array was employed, with electrode spacing progressively increased to achieve penetration depths of 50–70 m. Apparent resistivity values were recorded manually with the analog terrameter and processed through curve matching and inversion using IPI2Win software.

The digital terrameter was utilized to conduct 2D resistivity imaging, providing lateral subsurface profiles. Data were inverted using RES2DINV to generate resistivity models. Integration of both datasets allowed for vertical stratigraphy resolution (VES) and lateral aquifer continuity (ERT).

III. Result and Discussion

The analog VES results revealed a five-layer subsurface sequence characterized by alternating conductive and resistive zones. The top layer (1.77 m, 77.27 Ωm) represents silty clay overburden. Beneath it lies a clay-rich horizon (3.28 m, 34.99 Ωm), which is a non-aquiferous, impermeable unit. The third layer, a thick sand body (24.87 m, 575.57 Ωm), constitutes the primary aquifer zone, with favorable thickness and resistivity suggesting high yield potential. This is followed by another clay unit (44.2 m, 39 Ωm), which serves as a confining layer. The deepest layer (>44.2 m, 718.30 Ωm) corresponds to a secondary aquifer unit, possibly a confined sandy formation or weathered basement. The QH-type resistivity curve confirms the alternation of aquifers and aquitards typical of the Benin Formation.

Table 1: VES Result

S/N	Resistivity, ℓ (Ωm)	Depth (m)	Thickness (m)
1	77.27	1.77	1.77
2	34.99	5.05	3.28
3	575.5	29.92	24.87
4	39.00	74.12	44.2
5	718.30		

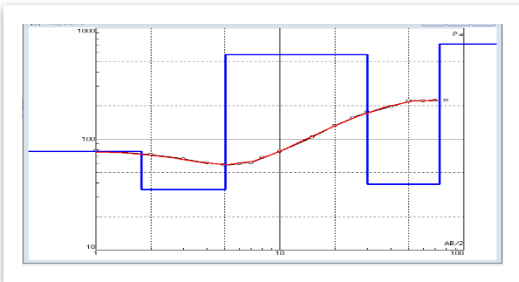

Figure 2: A Graph of VES Curve

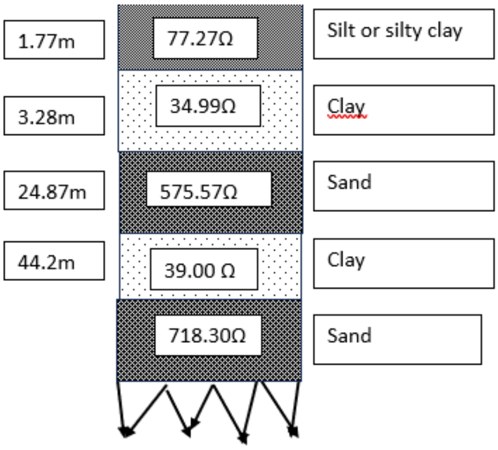

Figure 3: Geoelectric Section

The ERT inversion model (Figure 4) complements the VES findings by delineating laterally continuous freshwater aquifer zones, highlighted by resistivity values ranging between 0.10–0.34 Ωm (blue to green regions). These zones correspond spatially to the high-resistivity sandy aquifers delineated by the VES. The integration demonstrates the synergy between both techniques: VES resolves vertical layering, while ERT captures lateral heterogeneity, reducing uncertainties in aquifer characterization.

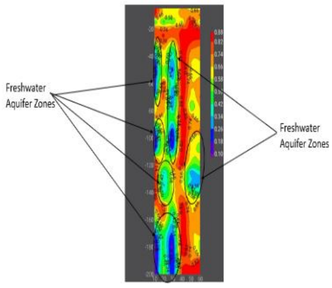

Figure 4: 2D Electrical Resistivity Tomography (ERT) inversion model.

Hydrogeologically, two aquifer systems were confirmed: (i) a shallow, thick sand aquifer at ~25 m depth, suitable for moderate-yield boreholes; and (ii) a deeper, confined sandy aquifer with higher resistivity, potentially offering more sustainable yield but requiring greater drilling investment. The intervening clay layers act as protective aquitards, reducing risks of contamination and saline intrusion.

The findings underscore the value of integrated geophysical methods in aquifer studies, particularly in urbanized sedimentary terrains where heterogeneity complicates groundwater exploration. Similar success has been documented in Etche and Ota regions (Okereke et al., 2021; Aizebeokhai et al., 2017), reinforcing the applicability of this approach across the Niger Delta.

IV. Conclusion

This study demonstrates that integrating VES and ERT provides a robust framework for aquifer characterization in the Benin Formation. Results reveal two significant aquifer units at shallow and deeper depths, separated by clay confining layers that safeguard groundwater quality. While VES provided detailed vertical resolution, ERT enhanced lateral mapping, improving confidence in borehole siting. The findings highlight the potential for sustainable groundwater exploitation within the Abuja Campus, subject to validation through drilling and pumping tests. The integrated geophysical approach applied here offers a practical model for similar groundwater investigations in sedimentary terrains.

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