ISSN 2350-1049

International Journal of Recent Research in Interdisciplinary Sciences (IJRRIS)
Vol. 13, Issue 1, pp: (53-58), Month: January - March 2026, Available at: www.paperpublications.org

SUBSURFACE MAPPING FOR GROUNDWATER PORTABILITY AT COMMUNITY SECONDARY SCHOOL NKPOLU: A DIGITAL TERRAMETER APPROACH

[1]Sam, Edikan Michael, [2]Njoku, Chibueze

[1] Department of Geology/Mining Technology, School of Science Laboratory Technology, University of Port Harcourt.

[2,] Department of Science Laboratory Technology, School of Science, Federal Polytechnic Ukana, Akwa IbomState

DOI: https://doi.org/10.5281/zenodo.18714966

Published Date: 20-February-2026

Abstract: **Access to safe and sustainable drinking water is a critical challenge in the Obio-Akpor Local Government Area, where rapid population growth and industrial activities have increased the risk of groundwater contamination. The primary objective of this study was to employ geophysical techniques to delineate potential freshwater aquifers within the school's premises. The study aimed to determine the subsurface lithology, overburden thickness, and water table distribution to guide the successful drilling of a potable water borehole. A geophysical survey was conducted using the Electrical Resistivity Method, specifically the Vertical Electrical Sounding (VES) technique with a Schlumberger electrode configuration. Data were acquired using an ABEM Terrameter (e.g., SAS 1000 or 300 models), which measured the resistance of subsurface layers. Interpretation of the VES data revealed multiple geo-electric layers, with topsoil, clayey sand, and prolific sand aquifers. Regional data suggests the water table in Obio-Akpor typically ranges from 1.6 to 9.0 metres, though deeper drilling is often required to reach uncontaminated potable sources. The survey identified the most viable borehole locations by pinpointing high-resistivity zones indicative of freshwater-bearing sands while avoiding potential saltwater intrusion zones. The use of a digital Terrameter provided a cost-effective and non-invasive means of aquifer delineation at CSS Nkpolu. The study recommends drilling to the identified deep-seated aquiferous zones to ensure a long-term supply of water that meets the Nigerian Standard for Drinking Water Quality (NSDWQ).**

Keywords: **Potable Water, Digital Terrameter, Vertical Electrical Sounding (VES), Aquifer Delineation, Obio-Akpor LGA, Rivers State.**

1. INTRODUCTION

Groundwater is commonly understood to mean water occupying all the voids within a geologic stratum. Groundwater is one of the nation's most valuable natural resources; it is the source of about 40 percent of the water used for all purpose's exclusive of hydropower generation and electric power plant cooling. Surprisingly for a resource that is so widely used and so important to health and to the economy of the country, the occurrence of ground water is not only poorly understood but is also, in fact, the subject of many widespread misconceptions. Common misconception includes the belief that ground water occurs in underground rivers resembling surface streams whose presence can be detected by certain individuals. These misconceptions and others have hampered the development and conservations of ground water and have adversely affected

ISSN 2350-1049

International Journal of Recent Research in Interdisciplinary Sciences (IJRRIS)
Vol. 13, Issue 1, pp: (53-58), Month: January - March 2026, Available at: www.paperpublications.org

the protection of its quality. Groundwater occurs everywhere but sometimes its availability in economic quantity depends solely on the distribution of the subsurface geomaterials that are referred to as the aquifers Delineating Aquifer is necessary because it helps in identifying and mapping the boundaries of an aquifer, which is a geological formation that can store and transmit groundwater. Several Geophysicists and researchers including Emenike, (2001); Amaresh, Raviprakash, Mishra, and Singh (2006): has reported its efficiency and effectiveness in prospecting for groundwater, fresh water/ saline water boundary predication and contaminant plumb predication. This process is crucial for groundwater management, water resource planning, and environmental protection. There are various methods used to delineate aquifers, including geophysical survey; which involves the use of techniques such as electrical resistivity, seismic reflection, and ground-penetrating radar to image the subsurface and identify the boundaries of the aquifer (Zohdy et al., 1989). Hydrogeological modeling; which involves the use of computer simulations to analyze the behavior of groundwater flow within the aquifer. This method can help in predicting the movement of groundwater and identifying potential recharge areas or sources of contamination (Singh & Singhal, 2011). And Drilling which allows for direct sampling and measurement of groundwater levels and quality. (Freeze & Cherry, 1979). One of the modern tools used in aquifer delineation is the digital tetrameter, which measures electrical resistivity. Aquifers are underground layers of water-bearing rock or sediment that hold groundwater. They are classified into unconfined and confined aquifers based on their geological surroundings. Accurate delineation helps in determining the quantity and quality of groundwater resources. It aids in identifying recharge areas, protecting water supplies, and managing contamination. The study is aimed at using a digital terrameter to delineation portable water in Community Secondary School Nkpolu, OBIO-AKPOR LGA . Rivers State. A useful approach to the study of the groundwater in regions is the use of relationships and comparisons between aquifer properties and between hydrogeological and geophysical parameters. Relationships between aquifer characteristics and geoelectric parameters have been studied and reviewed by many authors; Freeze & Cherry 1979 reported that over abstraction of groundwater due to increase in population was the major cause of saline intrusion. According to these authors, groundwater in the area of their study is portable and suitable for domestic, agricultural and industrial use. There studies were based on ground water quality. Again, an attempt has also been made to present and discuss the correlations between transmissivity estimates derived from geoelectrical soundings and specific capacity. Relationships between aquifer characteristics and geoelectrical parameters have been studied and reviewed by Kulke, 1995. Freeze & Cherry. Some researchers assume that the geology and ground water quality remain constant within the area of interest and the relationships between aquifer and geophysical parameters deduced are based on this assumption analyzed the correlation between aquifer and geoelectric parameters on both the saturated and unsaturated zones of the aquifers. The Romans built elaborate aqueducts to transport water from aquifers to their cities, enabling them to expand and thrive (Gleick, 2019). The Niger Delta is situated in the Gulf of Guinea and extends throughout the Niger Delta Province as defined by Klett, (1997). The delta has prograded southwestward, forming depobelts that represent the most active portion of the delta at each stage of its development from the Eocene to the present, Doust and Omatsola, (1990). These depobelts form one of the largest regressive deltas in the world with an area of some 300,000 km2 Kulke, (1995), a sediment volume of 500,000 km3, Kulke, (1995), and a sediment thickness of over 10 km in the basin depocenter.The Niger Delta Province contains only one identified petroleum system (Kulke, (1995); Ekweozor and Daukoru, (1994). This system is referred to here as the Tertiary Niger Delta (Akata – Agbada), Petroleum System.

2. MATERIALS AND METHOD

Data Acquisition

The Digital Terrameter (ADMT 200 series) was used to acquire data with two methods namely; SENSOR METHOD and Electrodes METHOD.

Sensor Method

This method the senor is connected directly to the Main frame with a control ADU App in a mobile phone that acts as the recording sheets and processor of data acquired. The instrument is connected to the APP through the built-in Bluetooth, so you can use the APP to realize all the operations of the instrument such as measurement signal input, data checking and processing. Using wireless sensor probe, you can complete all the measurements just by walking and stopping. No need long cable, saving time and manpower. Many innovative designs make the instruments become more intelligent, efficient, accurate and obtained dozens invention patents.

ISSN 2350-1049

International Journal of Recent Research in Interdisciplinary Sciences (IJRRIS)
Vol. 13, Issue 1, pp: (53-58), Month: January - March 2026, Available at: www.paperpublications.org

Data Acquisition Using Electrode Method

In this method 2 Electrodes are connected to the digital terrameter, and are pegged in the ground for subsurface investigations then after you go through the same process in both methods. The differences in both methods are; whilst the electrode method has two electrodes connected to the terameter and pegged in the ground, the sensor method uses only the terameter for investigation.

Hence, the contour closures for Aquifers in the Electrode Method are bolder and brightest than that of the Sensor Method. The Electrode Method probes deeper depths than the sensor method.

Field Operational Problems

There were errors in the resistivity reading when the parameter was wrongly connected. Hence, we ensure the electrodes were properly connected to the digital terrameter, for optimum performance/ result.

The phone shouldn't be too far from the digital terrameter in order to avoid disconnection form the AIDU Prospecting software.

3. RESULTS AND DISCUSSION

Interpretation of Resistivity Results

The concept of delineation of aquifer depths at the subsurface is a profound way of understanding aquifer formation within the Niger delta. However, the electrical resistivity method was deployed in this research to have a detailed look at the depth of potential aquifer formation within the study Area. This brought about the use of a Digital Tetrameter as a first way of delineating aquifer depths in a given area. This method is cheap, low cost effective, and involves less number of personnel's for it's operation. Two profiles were carried out so as to obtain information about the subsurface layers, one without electrodes, the other with 2 electrodes connected to the terrameter. These profiles were used to produce 2D contour Maps for subsurface interpretation. The aquifer depths encountered were 49.2ft, 393.6ft and 590.4ft respectively.

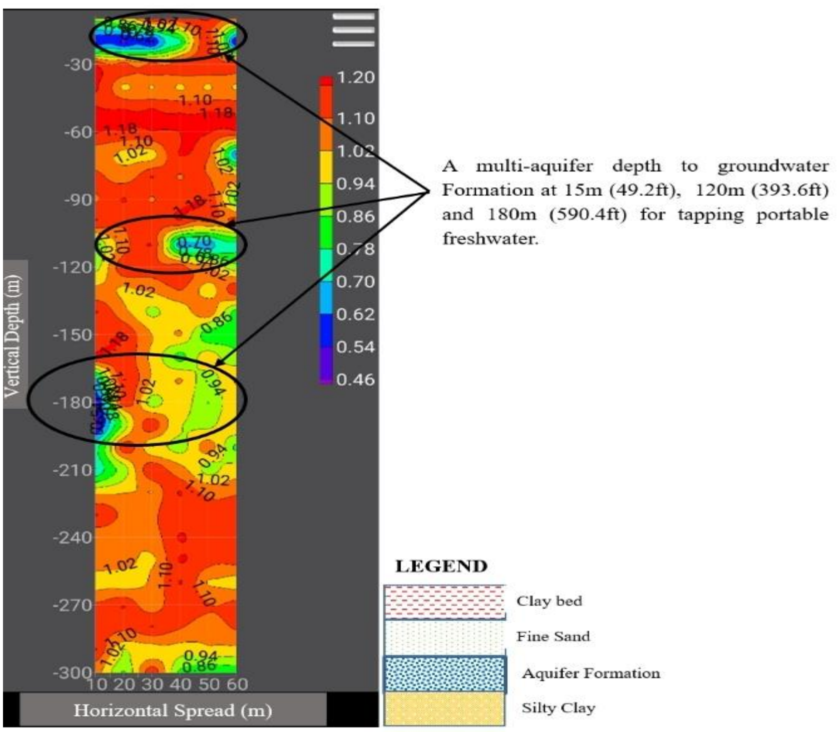

Figure 1: Result of Resistivity Model using Sensor Method 1

ISSN 2350-1049

International Journal of Recent Research in Interdisciplinary Sciences (IJRRIS)
Vol. 13, Issue 1, pp: (53-58), Month: January - March 2026, Available at: www.paperpublications.org

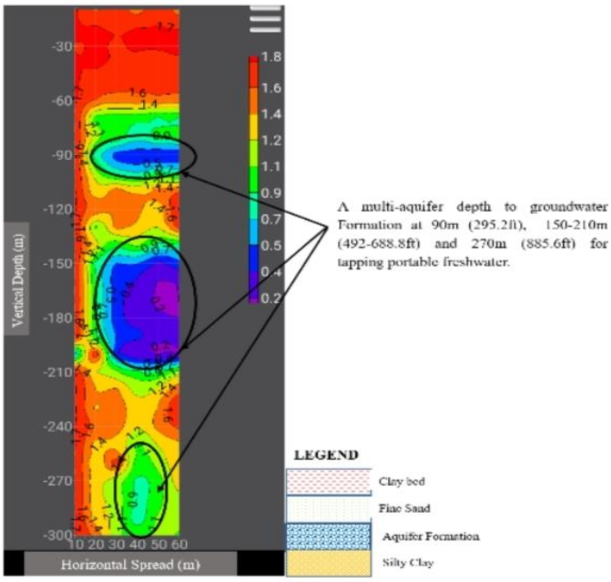

Figure 2: Resistivity Model using electrode method 2

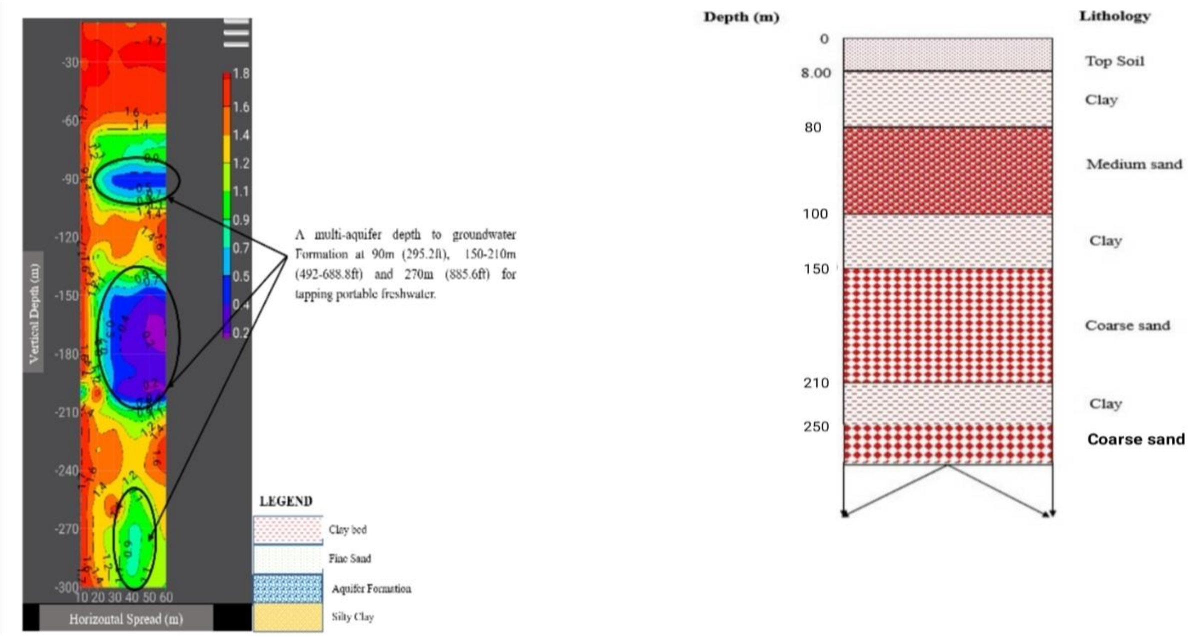

Figure 3: Geo-Electric Section of Resistivity Model 1

Concentrating Only on the Aquifer Of Importance

For The Resistivity Model;

The Blue zones indicates resistivity i.e sandstone for Aquifers.

Pale yellow or green shows low conductivity (silty clay)

The Red zones indicates clay beds i.e High conductivity

As you move up you're moving towards conductivity (your clays)

From the GEO-ELECTRIC SECTION of the above Resistivity Model, the top soil ranged from depth 0m - 7m.

At depth 15m (49.2ft) we got our first sandstone (fine sand) for aquifer.

ISSN 2350-1049

International Journal of Recent Research in Interdisciplinary Sciences (IJRRIS)
Vol. 13, Issue 1, pp: (53-58), Month: January - March 2026, Available at: www.paperpublications.org

Recall that 1meter equals 3.28feet. Hence, converting to feet 15m x 3.28 =49.2ft. Meaning when you drill up to depth 49.2ft you will get portable water.

At depth 110m -125m we met our second aquifer (medium sand)

120m x 3.25ft= 393.6ft

At depth 170m -195m we got our third aquifer (coarse sand)

180m x 3.28=590ft

Therefore, the depths to potential aquifers for profile 1 are; 49ft, 393.6ft and 590ft respectively

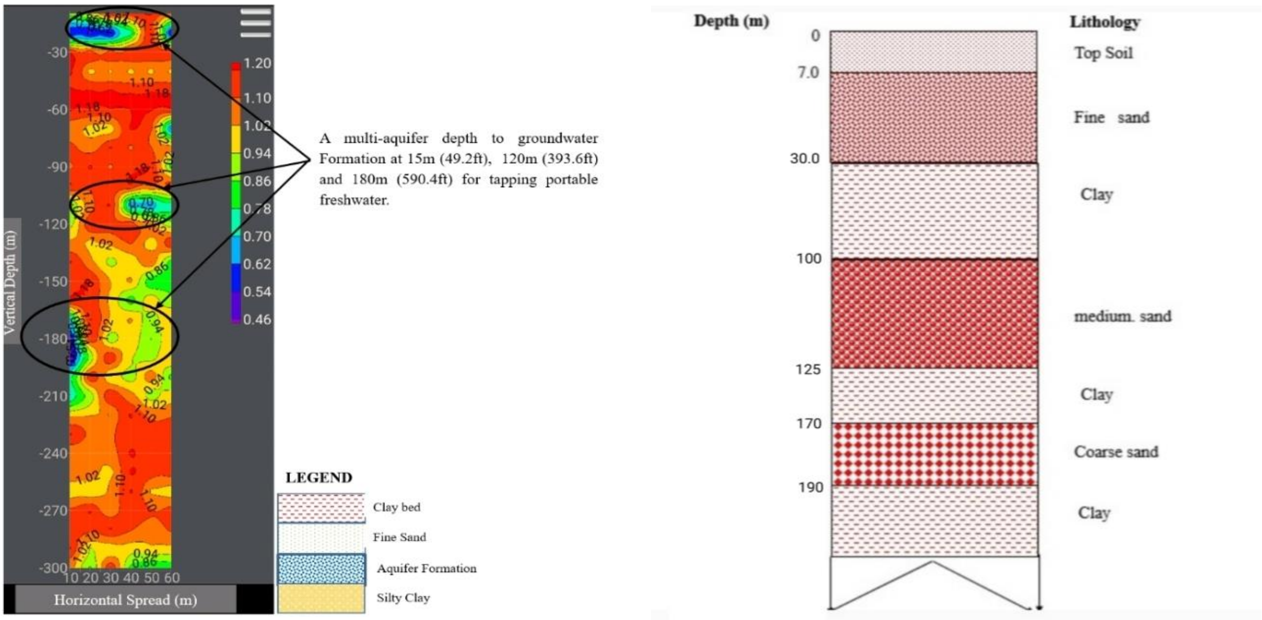

Figure 4: Geo-Electric Section of Resistivity Model 2

From the above GEO-ELECTRIC SECTION of Resistivity Model, we see that the top soil ranged from depth 0m -8m

At depth 90m we got our first sandstone for aquifer (medium sand)

Converting to feet

1m = 3.28ft

Hence 90m x 3.28ft =295.2ft.

At depth 150m -210m a bigger aquifer containing the largest amount of water was found. 150m x 3.28ft= 492ft

At depth 270m (885.6ft) another aquifer was found.

270m x 3.28ft= 885.6ft.

The second profile revealed depths of 295.2ft, 492- 688.8ft and 885.6ft respectively

The results (for both profiles) are indications of a multi-aquifer system of a typical Niger Delta Formation.

4. DISCUSSION

The use of electrical resistivity method for delineating aquifer depths in the study Area, through the use of a Digital Tetrameter has made this research a success. A digital terrameter is a device used to measure electrical conductivity, which can help identify the boundaries and characteristics of an aquifer. The method revealed variable depths to ground water formation from which aquifer depths can be extracted from (fig 1 and 2). The depth to potential aquifers are 49.2ft, 393.6ft and 590ft for the first profile, while the second profile revealed depths of 295.2ft ,492-688.8ft and 885.6ft respectively.

The Digital Tetrameter used can probe or investigate up to 300m (984ft). The results are the indications of a multi-aquifer system of typical Niger Delta Formation.

The result's produced two contour Maps that describes the changes in resistivity properties with respect to the depth of investigation. The depth positions on the contour Maps shows the presence of sandstone formation that has the ability and capacity to house reasonable quantity of ground water in the study area. This method allows for a relatively quick and effective way to delineate aquifers, especially in areas where traditional methods may be more challenging or costly.

5. CONCLUSIONS

The use of electrical resistivity method for delineating aquifer depths in Community Secondary school Nkpolu, OBIO-AKPOR LGA, River's State, through the use of a Digital Tetrameter has made this research a success. The method is a low cost effect compared to other geophysical methods and has brought great insight to the rock layers across the area. The method revealed variable depths to ground water formation from which aquifer depths can be extracted from .The depth to potential aquifers are 49.2ft, 393.6ft and 590ft for the first profile, while the second profile revealed depths of 295.2ft ,492-688.8ft and 885.6ft respectively. The Digital Tetrameter used can probe or investigate up to 300m (984ft). The results are the indications of a multi-aquifer system of typical Niger Delta Formation. In summary, aquifer delineation using a digital tetrameter is a vital technique in hydrogeology that enhances our understanding of groundwater resources, ultimately contributing to better management and protection of these essential water supplies.

REFERENCES

[1] Doust, H. and Omatsola, E., (1990): Niger Delta, in J. D. Edwards and P. A. Santogrossi, eds., Divergent/passive margin basins: American Association of petroleum Geologists Memoir 48: 201-236.

[2] Doust, H. and Omatsola, E., (1990): Niger Delta, in J. D. Edwards and P. A. Santogrossi, eds., Divergent/passive margin basins: American Association of petroleum Geologists Memoir 48: 201-236.

[3] Ekweozor, C. M. and Daukoru, E. M., (1994): Northern Delta depobelt portion of the Akata-Agbada petroleum system, Nigeria, In, Magom, L. B., and Dow, W. G., eds. The petroleum system-from source to trap.American Association of petroleum Geologists Memoir 60: Tulsa, 599-614.

[4] Ekweozor, C. M. and Daukoru, E. M., (1994): Northern Delta depobelt portion of the Akata-Agbada petroleum system, Nigeria, In, Magom, L. B., and Dow, W. G., eds. The petroleum system-from source to trap.American Association of petroleum Geologists Memoir 60: Tulsa, 599-614.

[5] Emenike, (2001); Amaresh, Raviprakash, Mishra, and Singh (2006): Aizebeokhai AP, Olayinka AI, Singh VS (2010). Application of 2D and 3D geoelectrical resistivity imaging for engineering site investigation in a crystalline basement terrain, southwestern Nigeria. Journ. Environ. Earth Scien., DOI: 10.1007/s12665-010-0474-z, 1359-1481.

[6] Emenike, E. A. (2001). Geophysical exploration for groundwater in a sedimentary environment. A case study from Nanka formation in Anambra basin Southeastern Nigeria. Global Journal of pure and applied sciences, 7(1): 1-11.

[7] Freeze, R. Allan, and Cherry, John A. Groundwater, Prentice Hall, 1979.

[8] Gleick, P.H. "The World's Water: The Biennial Report on Freshwater Resources." Island Press, 2019.

[9] Klett, T. R., Ahlbrandt, T. S., Schmoker, J. W. and Dolton, J. L. (1997). Ranking of the World's oil and gas provinces by known petroleum volume. United States Geological Survey open file report, 56-58.

[10] Kulke, H., (1995): Regional petroleum Geology of the world. Part II: Africa, America, Australia and Antarctica: Berlin, Gebruder Borntraeger, 143-172.

[11] Kunetz G (1966). Principles of Direct Current Resistivity Prospecting. Gebruder Borntraeger, Berlin, 98-103.

[12] Singh, Vijay P., and Singhal, Bhawani S. Hydrogeology: Principles and Practice, John Wiley & Sons, 2011.

[13] Zohdy, Adel A., et al. Application of surface geophysics to groundwater investigations, United States Geological Survey, 1989.