GSJ: Volume 12, Issue 10, October 2024, Online: ISSN 2320-9186
www.globalscientificjournal.com

Groundwater Explanation at Nembe Creeks 2, Bayelsa State, Nigeria.

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Keywords: *Groundwater Resistivity, Electrodes, Subsurface, Geophysical, Aquifer, Vertical Electrical Sounding.*

Abstract

This study investigates groundwater potential in the Nembe Creek 2 area, Bayelsa State, using vertical electrical sounding (VES) to delineate suitable aquifers for sustainable water supply. Employing the Schlumberger array with a maximum electrode spread of 280 meters, the resistivity survey provides insights into subsurface lithological variations. Four distinct geoelectric layers were identified: an organic/peaty clay top layer, a fine- to medium-grained sand aquifer-prone layer, a non-aquiferous organic clay layer, and a saturated, medium-grained sand layer deemed prolific and suitable for aquifer development. The findings indicate that groundwater potential in the Nembe Creek area is concentrated within the deeper saturated sand layer. Based on these results,

we recommend drilling to a depth of 270 feet to optimize water extraction. This study contributes to a better understanding of the hydrogeophysical characteristics of the region and provides practical guidance for groundwater resource development.

1. INTRODUCTION

In the shallow subsurface, the presence of water controls much of the conductivity variations. Measurement of resistivity (inverse of conductivity) is in general, a measure of water saturation, porosity and permeability. This is because electrical conductivity of the subsurface is primarily by the means of dissolved ions in solution (electrolysis). Therefore, an increase in ions concentration (salinity), porosity and permeability tend to decrease measured resistivity. Conversely, increase in compaction of soil (will expel water) and the presence of air in the void spaces (as in the vadose zone) results in an increase in measured resistivity. So in view of the foregoing, hydro-geophysical survey has been widely applied in interpreting the lithologic and geohydrologic models of the subsurface.

The electrical resistivity survey was carried out in order to identify suitable aquifers that can be exploited for groundwater supply at the investigated location. A team of hydro-geophysicists and engineering geologist from the IX Sngergy ltd, Rivers state, carried out the field investigation on the 19th of May, 2024 at the aforementioned location. One vertical electrical sounding was carried out using the half Schlumberger field configurations, with a maximum electrode spread of 280m. The sets of data obtained were analyzed in accordance with best international practices.

GSJ: Volume 12, Issue 10, October 2024
ISSN 2320-9186

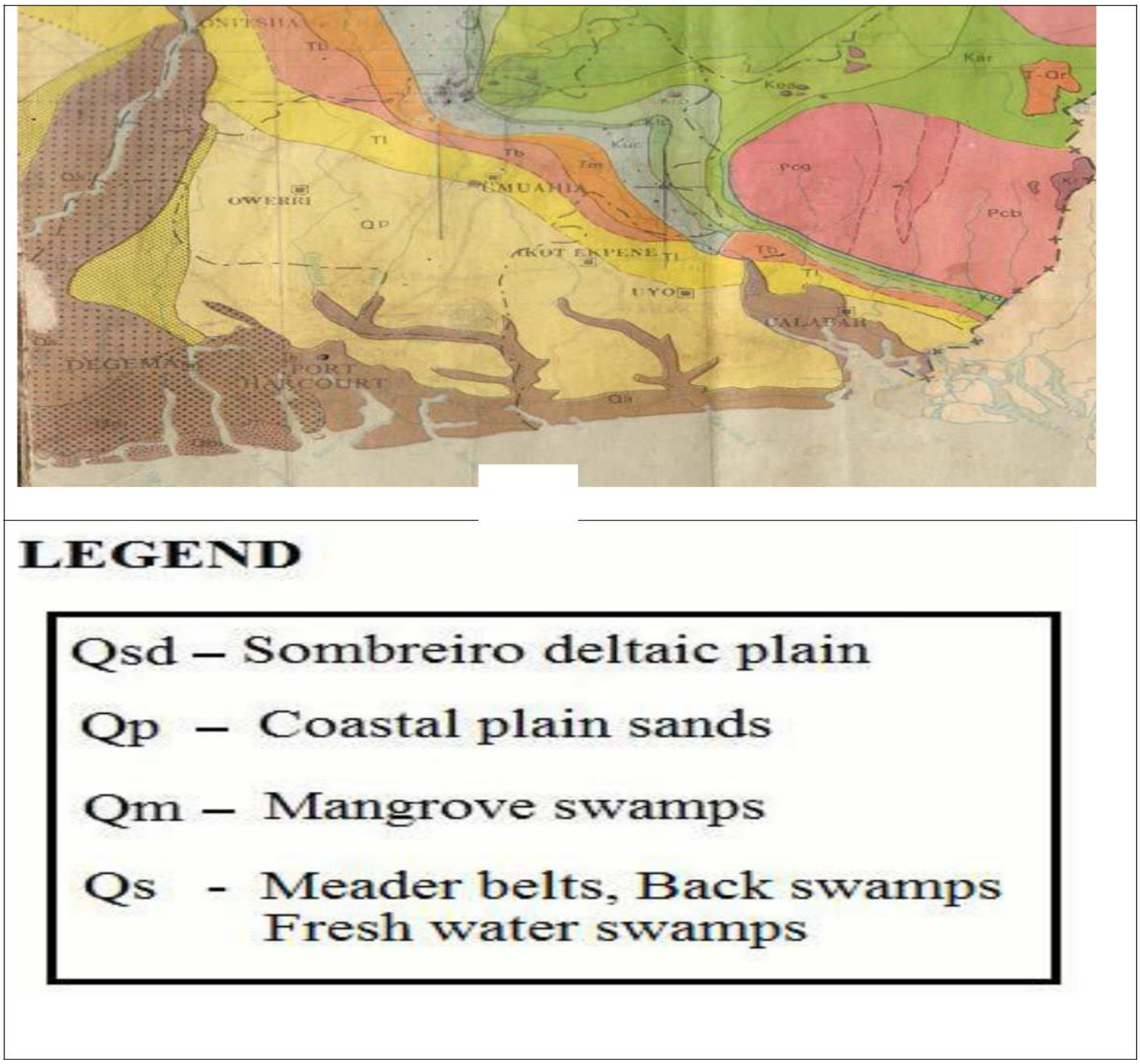

Fig 1: Geological Map of the surveyed area.

2. MATERIALS AND METHODS

Herojat Rhomega resistivity meter with internal power source

Non polarizing electrodes (four pcs)

Hammer

Measuring tape

Cable reels

Communication gadgets

Field notebook

Camera

2.1 ELECTRICAL RESISTIVITY SURVEY METHODOLOGY

Geophysical resistivity techniques are based on the response of the earth to the flow of electrical current. In these methods, an electric current is passed into the ground through two current electrodes and two potential electrodes placed in-between allow us to record the resultant potential difference between them, giving us the way to measure the electrical impedance of the volume of subsurface material being investigated. The apparent resistivity is then a function of the measured impedance (ratio of potential to current) and the geometry of the electrode array. See equation 1. The measured resistivity is called apparent because the earth is anisotropic in nature. A generalized field configuration for resistivity survey is given in Figure 2.

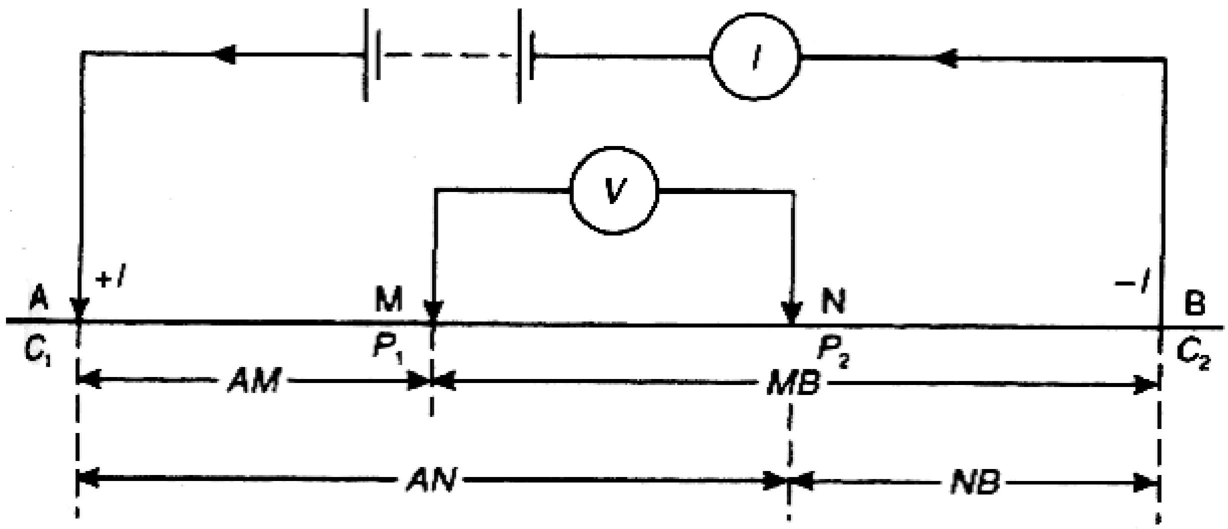

Figure 2: Generalized field configuration

The nature of the spatial arrangement of electrodes gives rise to the different field configurations in resistivity surveys. The suitability of anyone preferred, depends on the equipment being used, the geology of the study area, the purpose of the survey and logistics of the field work. Some of the popular configurations include; Schlumberger, Wenner, Dipole-Dipole, Pole-Dipole, Lee – Partitioning array etc. However in this project, Schlumberger array was used, because it has comparative advantage over the rest, in terms of its higher sensitivity to changes in resistivity with depth and logistics ease. In Schlumberger array, four electrodes are positioned symmetrically in a straight line as shown in Figure 3. Current is sent into the ground via the current electrodes **AB**, and the potential difference between the potential electrodes **MN** is recorded. After each measurement, the current electrodes are moved outward, relative to the potential electrodes. In order to maintain a measurable potential at large distances of current electrodes, it is necessary to expand the potential electrodes after a series of measurements.

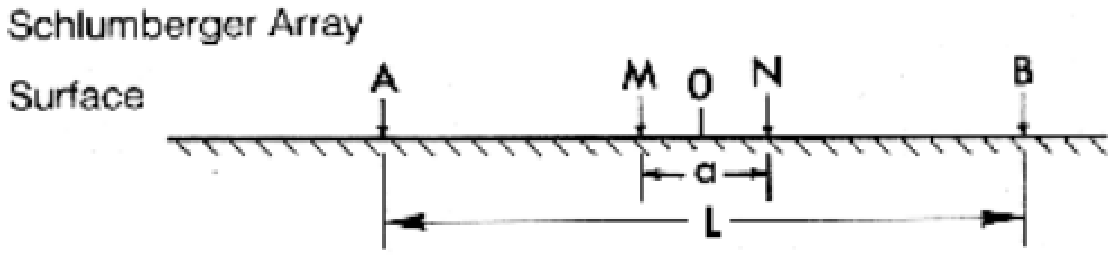

Figure 3: Schlumberger array schematic

The relationship between the current electrode spacing and potential electrode spacing is such that MN20%AB. Apparent resistivity is calculated from Schlumberger array as follows;

ρ_a=----------(1)

Where;

AB is the current electrode spacing

MN is the potential electrode spacing

is the potential difference

I is the injected current

2.3. DATA COLLECTION AND INTERPRETATION

The field data was collected in the month of May 19th, 2024 at the aforementioned location, using the half Schlumberger field configuration. The vertical electrical sounding station was geo-referenced using Polaris Mapping application on an Android device. One sounding station was acquired with a maximum electrode spread of 280m. The data obtained from the field was interpreted using Micro-Soft Excel and IPI2WIN computer inversion Software. The latter automatically calculates the resistivity versus thickness model from the measured apparent resistivity and fixed in the appropriate model.

The interpreted geo-electric layers are given in Table 1, while the apparent resistivity curves along with their modeled geo-electric parameters as well as the field datasheets are attached in the appendix of this report. The reference coordinates of the investigated site are contained in the attached field datasheet.

Table 1: interpreted geo-electric layers at the investigated location NEMBE 2 VES 1

Layer	**ρ (Ωm)**	**Depth (m)**	**Layer thickness**	**Inferred Lithology**	**Remarks**
1	18.2	0 – 1.80	1.80	Organic clay/Peaty	Non aquiferous
2	288	1.80– 9.18	7.32	Fine to medium grain-size sand	Aquiferous prone to surface contamination
3	12.6	9.18– 49.2	40.0	Organic clay	Non aquiferous
4	**403**	**49.2-84.0**	**34.8**	**Saturated medium**	**aquiferous**

3. RESULTS AND DISCUSSION

Resistivity of rocks gives an indication of the type of rock and its fluid content. Low resistivity readings in basement rocks environment, signify the presence of fractures, increased saturation, porosity and permeability, all of which are diagnostic properties of an aquifer. But in sedimentary rocks environments as the investigated site, low readings are indicative of shale and clay. In view of the foregoing, a concise interpretation of the processed geophysical data is given in Table 1.

Four lithological units were inferred in table 1 and they consist of an organic/peaty clay top layer, followed by a layer of fine to Medium grain-size layer. The subsequent layers in order of occurrence include third layer of organic clay which is non-aquiferous and fourth layer consist of **Saturated medium grain-size sand** constituted which is prolific and aquiferous.

From the forgoing results within the investigated site. We recommend that the borehole in Nembe creek 2 should be drilled to depth of 270 feet and a treatment should installed.

4. CONCLUSION

The hydro-geophysical survey was carried out on the 5th of June, 2021 at Nembe creek 2 site, at OML29. The survey was carried out to identify the most suitable depth to drill a water borehole in the area. A sounding was done with a maximum electrode spread of 280m, aquiferous intervals were successfully delineated.

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