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Research Article

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Application of Hydro Geophysical Survey as a Tool for Determining Presence of Groundwater Resources: A Case Study of School of Agriculture Mgbakwu, Anambra State, Nigeria

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Abstract This paper discusses the occurrence and search for groundwater at school of Agriculture Mgbakwu, in Anambra State, Nigeria as indicated by result of vertical electrical soundings (VES). The project area lies within Longitudes 7°6' E -7° 54'E and Latitudes 5°56'N-6 °52'N, and covers an area spread extent of about hundred plots of land within over seven main geological formations. The thickness, lateral extent and transverse resistance of the aquiferous layers were determined by the geoelectrical survey. Water table information from existing boreholes and hand dug wells records were used to compliment the survey. The data acquired was also used in delineating the geoelectric sections. The study was carried out using the Schlumberger electrode configuration. The interpretation of the resistivity curves over the study area within geologic terrain often referred to as sedimentary environment indicates that the area have groundwater potential. The experiment conducted over the area showed a total depth of 580 and 650 feet respectively which corroborated with ground water data acquired from the existing boreholes and hand dug wells in the study area.

Keywords Resistivity, Transverse resistance, Anambra State, Schlumberger, Borehole, Aquifer, Ajali sandstone

Introduction

A Hydro-geophysical survey and study of the subsurface geology of proposed water borehole site located at school of Agriculture Magbakwu, Anambra State was carried out. The aim was to determine a feasible point to drill a productive borehole for the school. The advent of technology has made the quest for water for all purpose in life to drift from ordinary search for surface water to prospecting for steady and reliable subsurface or ground water from boreholes and hand dug wells using scientific methods. Groundwater is a valuable natural resource that is of immense importance to life. It is naturally stored in the pore and void spaces within geologic unconsolidated formation. Its availability and characteristics are greatly determined by the properties of the immediate geologic formations [1].

In Nigeria, presently, boreholes have rescued the citizenry from acute shortage of water. Groundwater is characterized by a certain number of parameters which are determined by geophysical methods such as electrical resistivity methods, seismic methods, magnetic methods, gravity methods etc [2]. But for this research work, the application of electrical resistivity survey method was used. The most usual parameters are the porosity, the permeability, the transmissivity and the conductivity. The survey conducted revealed the subsurface geology of the proposed drilling site and gave detailed information regarding the Lithology, aquifer

geometry and area spread extend, total drill depth, quantity and quality of the groundwater. It is expected that all estimates of cost and material inputs will depend on the survey result.

Methodology

Electrical resistivity varies with rock or sediment type, porosity and the quality and quantity of water and is a fundamental property of earth materials [3].

This method responds favourably to measurable parameters that can easily distinguish the aquifer from other formations. The conductivity (resistivity reciprocal) variations of formations will enable one delineate different layers using the ABEM Terrameter.

A total transverse spread (L) of 300ft was covered (L/2) on the left and another 300feet (L/2) on the right. The total traverse was run parallel in front of the school premises.

The equipment used for the fieldwork was the versatile Abem Terrameter. The apparent resistivity, which is the normal quantity determined from the field measurement, is not a physical constant, but reflects the distribution of the true resistivity in the subsurface, and depends on the spatial configuration of the measuring systems of the possible electrode configuration used in measuring resistivity, the Schlumberger arrangement was the one employed in the present study. Apparent resistivities were obtained from the field resistance values using the equation:

Pa = II (L2 – b2) R

Where

Pa	=	Apparent Resistivity on Ohm – meter
L	=	Distance between current Electrodes
B	=	Distance between potential Electrodes
R	=	Resistance of the ground

The survey lasted between 2pm to 4pm under favourable weather condition. All necessary precautions required in geo-electric measurement were duly considered.

Geological units of the study area within Anambra Basin

The subsurface geology of the project site falls within the sedimentary Basin of Anambra/ Imo River basin, but associated with the transition area of Lignite/Limestone/indurated sandstone/mudstone and shale Formation.

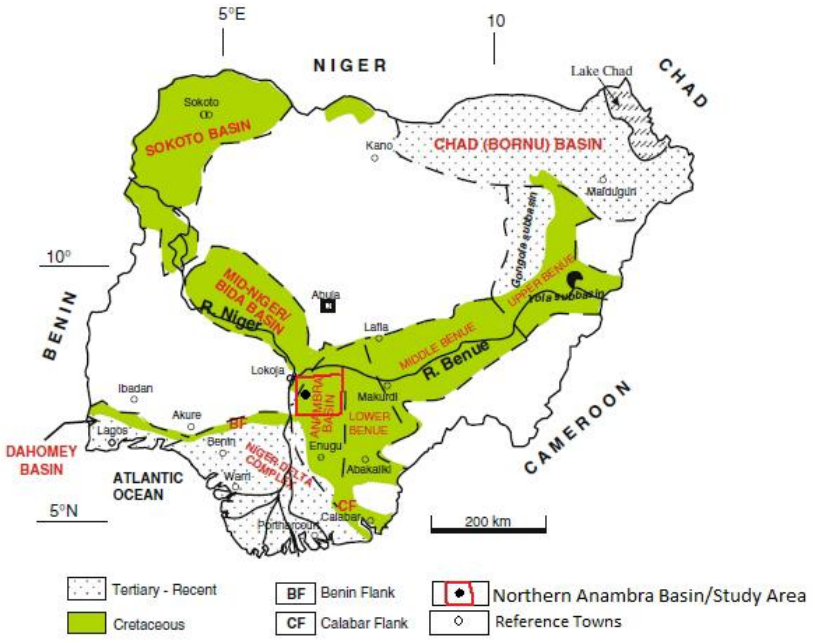


Figure 1: Map of Nigeria showing the Study area adopted from Kogbe, C.A. [4]

The underlying Lignite Formation consists essentially of Shale, Mudstone, Clay and Lignite Series. The survey indicated the area is drained with saturated water bearing formation and borehole in the school compound is viable but not without some geological problems due thickness of shale / clay deposits deposit

The Anambra Basin is dominantly filled with clastic sediments constituting several distinct lithostratigraphic units ranging from Upper Campanian to Recent in age. The lithostratigraphic units have a thickness of up to 2500m [5] and consist of Nkporo Shale, Mamu Formation, Ajali Sandstone, Nsukka Formation, Imo Shale, Ameki Formation, Nanka Sands, Ogwashi-Asaba Formation, Benin Formation and the alluvial plain Sands. The source of the sediments into the basin is principally from the Cameroon massif and the Abakaliki synclinorium [6]. The general stratigraphy of the Anambra basins is presented in Table 1 below.

Table 1: Sequence strategraphy in south eastern Nigeria (Modified from Reyment, R.A. [5])

Age	**Formation**	**Tectonic phases an sedimentary cycle**
Pliocene Pleistocene	Benin Formation	Niger Delta Basin developed from the upper Eocene (third tectonic phase-third sedimentary cycle)
Miocene	Ogwashi-Asaba formation	Anambra-Afikpo Basin (second Tectonic Phase-Second Sedimentary Cycle)
Eocene	Ameki Formation	
Paleocene	Imo Shale	
companion Danian.	Nsukka formation (upper coal measure)	
	Ajali sandstone (false bedded sandstone)	
	Mamu formation (coal measure)	
Santonian	Awgu Shale	Abakaliki-Benue Basin (First tectonic phase-First Sedimentary Cycle)
Coniacian		
Turobian	Eze-Aku Shale	
Cenomanian	Odukpani Formation	
Albian	Abakaliki Shale	

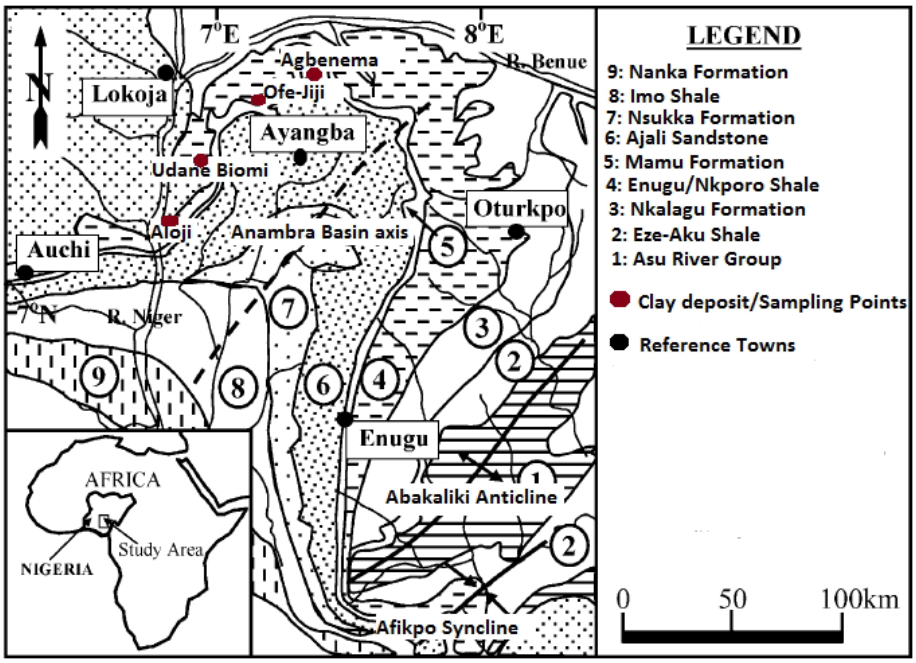
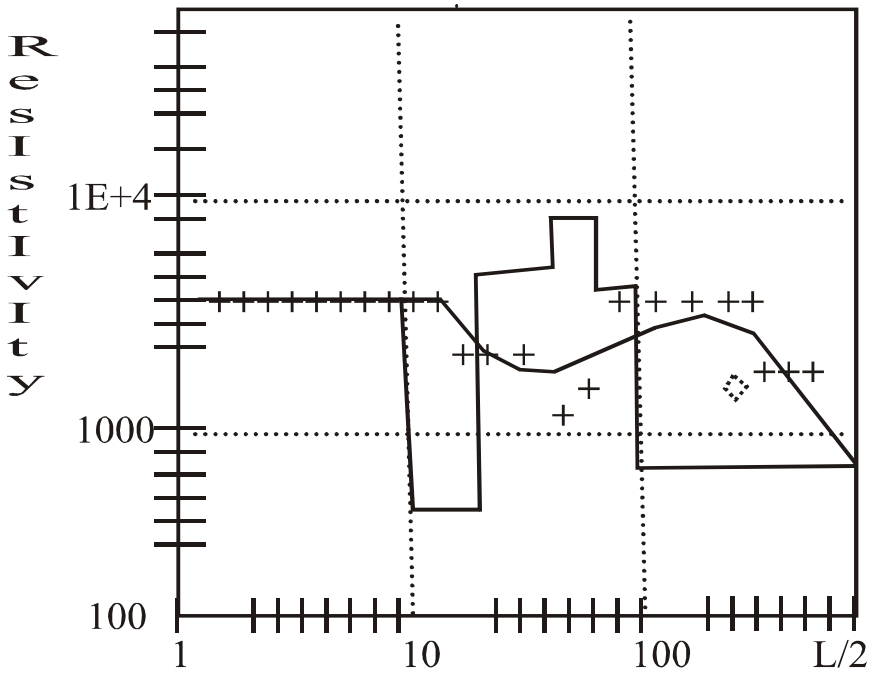


Figure 2: Map of Anambra River Basin adopted from Reyment, R.A. [5]

Geoeletrical laying for vertical and horizontal sounding at ASUDEB new office.
Compound Onitsha, Anambra State.



Project name	SURVEY		Direction lay out	Sounding Station	
Code name	GEOPHYSICS		Remarks	WATER BOREHOLE	
Coordinates	Mgbakwu		Schlumberger	School of Agriculture	

L/2 (m)	Rho (0hm.m)	L/2 (m)	Rho (0hm.m)	L/2 (m)	Rho (0hm.m)
1.5	3950.0	14.0	3080.0	95.0	3500.0
2.5	3850.0	18.0	2115.0	125.0	3580.0
3.5	3850.0	24.0	2115.0	160.0	3700.0
4.5	3850.0	32.0	2115.0	200.0	3700.0
6.0	3850.0	42.0	1250.0	200.0	2070.0
8.0	3850.0	55.0	1600.0	250.0	2120.0
10.0	3850.0	75.0	3310.0	350.0	2180.0

Resistivity (0hm.m)	Depth (m)
4060.0	80.7
561.0	123.9
5680.0	150.4
12700.0	210.1
14600.0	213.8

Result(fm)
The required depth is
+213M OR 702.90FT

The survey intercepted 7 geo-electric layers or Lithologic units as follows:

Layer	**Thickness(ft)**	**Lithology**
X		
1	0-80.7	Dry sandy Top Soil (sandy)
2	80.7-123.9	Lateric sands highly ferreginzed
3	123.9-250.4	Sand with clay/shale intercalation
4	250.4-410.1	Sand, semi consolidated shale
5	410.1-580.1	Limestone with intercalation of mud stone and heavy clay shale deposit (Unsaturated)
6	580.1-650.1	Sand-prospective saturated Aquifer unit (water bearing)
7	650.1-Infinity	Transition to shale base

Discussion

The geology of the study area reveals that the entire area is underlain by sedimentary rocks. These rocks are of ages between Paleocene to recent [5]. The sedimentary rock contains about 90% of sandstone and shale intercalation. It is coarse grained locally fine grained in some areas, poorly sorted, sub-angular to well rounded and bears lignite streaks and wood fragment [6]. The sedimentary rock of the study area constitutes of seven geological formations, but the most important of the units is Ajali sandstone which was encountered at depth of 470 feet (After Imo shale acting as an impermeable layer). This has an important groundwater reservoir. The interpretation of geoelectric sections curves within geologic terrain indicates that the area has high level of groundwater potential. A correlation of the curves with the lithologic log from a nearby borehole suggests the same too.

Conclusion and Recommendation

The conducted hydro geophysical survey at Mgbankwu town within geologic terrain of Anambra River basin indicates that the area has high level of groundwater potential but can only be achieved through deeper penetration of all the overlaying lithologic sections.

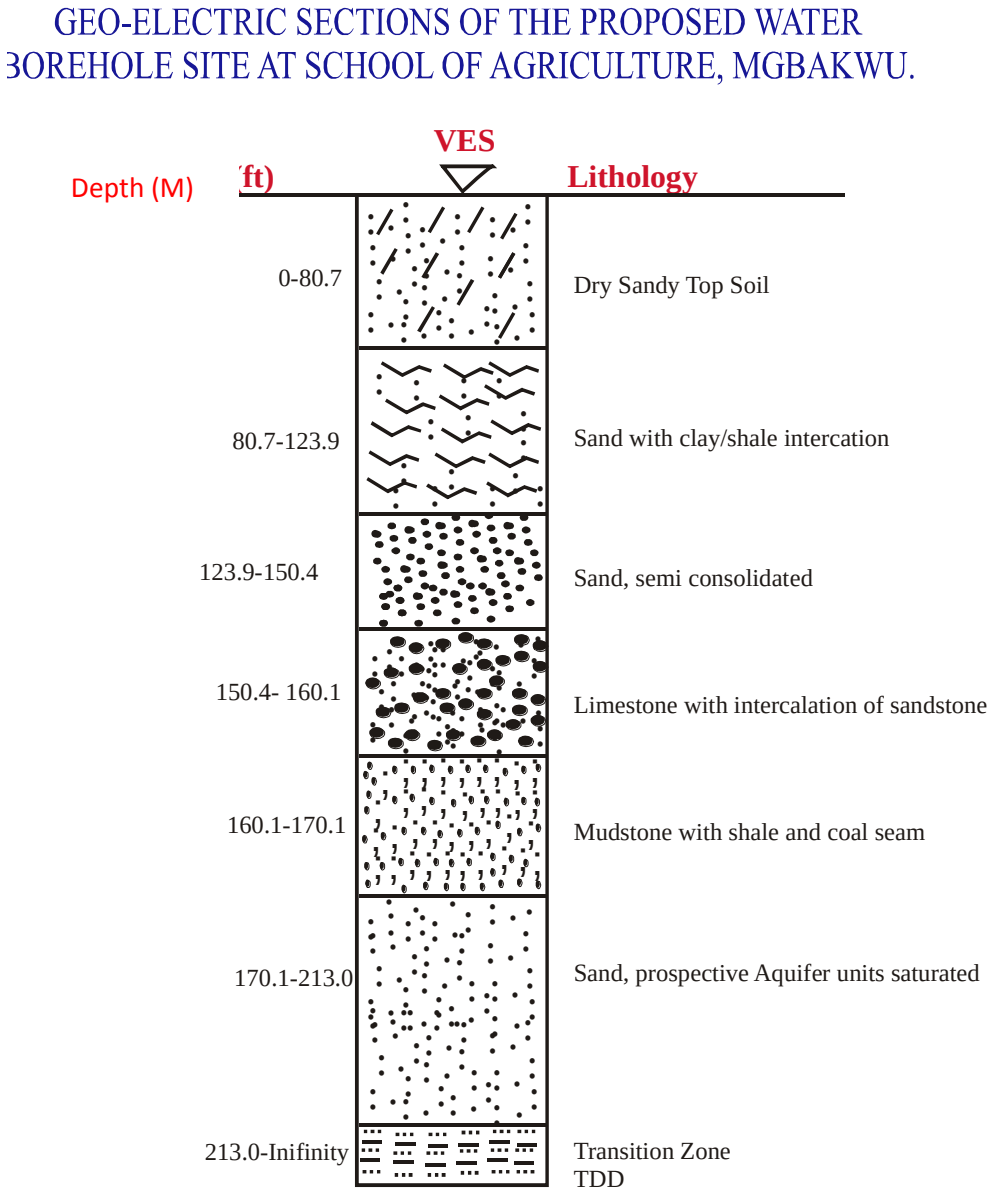


Figure 3: Geo electric section of the proposed borehole at the study site as revealed by the hydro geological survey. (Source from present work)

A total drill depth (TDD) of 580-650 feet was recommended as most ideal based on the conducted survey. During drilling, return cuttings were recommended to be collected at 10 feet drilled depth interval and should be used to study grain-size, colour and lithology associated interstitial materials useful in the determination of screen slot and gravel pack specifications. After drilling to target depth, the borehole must be log for electromagnetic properties including spontaneous potential and resistivity (16''short normal and 64'' long normal) using ABEM Terrameter. In the absence of observation wells, all measurements during pumping tests should be done on the pumping wells. An integration of the results of pre drilling geophysical survey, hydro geological/geological survey, drill cuttings, granulometric analysis, down-hole logging, drill time and pumping test/analysis for the surveyed borehole, should be employed in achieving a standard borehole that will yield economically and in commercial quantity.

Drilling may terminate shortly before the recommended TDD on interception of shale base.

For whatever is the diameter of casing pipes, there must be a minimum of 4" annulus for gravel packing. This will allow enough inflow of groundwater.

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