Lithostratigraphy of Nigeria An-Overview

Shitta Kazeem Akorede*,

Corresponding author: Geotech Nigeria Limited, KLM 8/9 Podo New Garage,
Old Lagos Bye-Pass, Ibadan, Oyo-State,Nigeria
. E-mail address: kazy1424@yahoo.com (K.A Shitta).

Abstract

Nigeria lies very close to the equator (hot country) West coast Africa between latitude 4° N and 14° N degree and longitude 2° E and 15° E degree. The country is located at the Northern end of Eastern branch of west coast of Africa rift system. Nigeria geological set up comprises broadly sedimentary formation and crystalline basement complex, which occur more or less in equal proportion all over the country. The sediment is mainly Upper Cretaceous to recent in age while the basement complex rocks are thought to be Precambrian. The studied area lies between latitude 12.4° and 11.11°W and longitude 13.81° and 14.13° S. The studied area is underlain by Precambrian basement complex of southern western Nigeria .The major rock in the area is charnokite and granite rock. The granite rock which is member of the older granite suite occupies about 65% of the total area .The principal granite is petrographic variety are recognized .The fine grained biotite-granite medium-coarse, non porphyritic biotite -hornblende granite and coarse-porphyritic biotite -hornblende granite. Also three main textural type of Charnokitic rock are also distinguished are coarse grained, massive fine grained and gneissic fine grained .The mode of occurrence of rock is three (1) core of the granite rock as exemplified by study area and few smaller bodies (2) Margin of the granite bodies as seen in Ijare and Uro edemo-idemo Charnokitic bodies and (3) Discrete bodies of the gneissic fine grained Charnokitic rock within the country gneisses as seen in Ilaro and Iju and Emirin village. All the charnokite in the region are dark-greenish to greenish-gray rocks with bluish quartz and greenish feldspar.

Keywords: *Geology of the study area; Occurrence; Textural; Petrography; Colour;*

1. Introduction

Water is known to be a universal solvent. It is also one of the natural resources tapped by man, animals and plants to meet their needs for life sustenance. The world's water resources include the entire range of natural waters on earth, either in vapour, liquid or solid form. Water is classified as surface water or groundwater. Surface water include rain water collected into rivers, lakes, reservoirs and oceans while groundwater include natural springs, well and boreholes.

Groundwater is commonly understood as water occupying the voids within a geologic stratum, groundwater is free from suspend matter and bacteria. It can be said to be pure, clear and colourless. Groundwater has greater quality than surface water. About 495,000 children die annually of various diseases due to drinking of water that are not properly safe and sanitize (sea, stream e.t.c.), even as population increases and industries required all over the world, most people generally required about 2.5 litres of water everyday for direct consumption. The average amount of water used domestically each day by every person is about 190 litres (Hamill and Bell, 1986).

Generally, industries require approximately one quarter to one third of the public water supply under normal condition the easiest and most convenient way to meet the public demand for water is to utilize surface water resources, but unfortunately, water such as river, lake, stream e.t.c. are less plentiful than can be imagined. It can be recorded that surface water resources account for less than 2 percent of the world's fresh water.

The latter fresh water available however is unevenly distributed while the sources that are available have been either contaminated or polluted. (Hamill and Bell, 986).Groundwater accounts for about 98 percent of the world's fresh water and is fairly evenly distributed throughout the world. It provides a reasonable constant supply which is not completely susceptible to drying up under natural condition unlike surface water (World water balance and water resources of the earth UNECO Copyright 1978).

All over the globe, groundwater has been a very good and important source of water supply. It has been of continuous and tremendous use in irrigation industries and urban centers, as well as in rural communities. It is conveniently available at point of use and possesses excellent quality that requires little or no treatment in most cases.

2. Occurrence of Groundwater

The concept which explains the ultimate destination of rainwater is the sea either directly through run off or indirectly be infiltration and subsurface flow. A system of water movement in the atmosphere or rainfall, dews, hailstones or snowfalls over land as run off. Vertical and horizontal movement underground as infiltration or subsurface and continuous movement of all forms of water is the hydrogeology cycle.

In the atmosphere, water vapours condense and may give rise to precipitation. However, not all this precipitation will reach the ground surface; some are intercepted by vegetation cover or surface of building and other structures and then evaporate back into the atmosphere. The precipitation that reaches the ground surface may flow in to stream, lake and ocean, where it will either be evaporated or form seepages intruding in to the ground likewise soil moisture and further percolate downward to underline aquifer where it may be held for several years longer.

Groundwater in Nigeria is restricted by the fact that more than half of the country is underlain by crystalline basement rock of pre-cambian era. The main rock types in this geological terrain include igneous and metamorphic rock such as migmatites and granite gneisses.Generally in their unaltered form, they are characterized by low porosity and permeability. Porosity in basement rocks is by induction through weathering while secondary permeability induces by tectonic activities which manifest in form of that often act as conduct path facilitating water movement.

In other words, aquiferous zones in the basement terrain include fractured/weathered rocks. The yielding capacity of well, drilled within such rock are always very enormous.

Research Methodology

(1) Literature Review: All available geological/hydrological information were collected through the reading of journal, reference seminar paper (Olorunfemi M.O., 1990)

(2) Data Gathering: All vertical electrical sounding data were collected from water section of the Federal Ministry of Agriculture and Water Resources Abuja, Wenner array was used in collecting the date.

(3) Data Analysis: The data were interpreted by using partial curve matching technique. Computer was then used to interpret the results, from the result obtained geoelectric sections were generated.

(4) Interpretation of Results: Result obtained from each VES station were completed and interpreted in order to determine the best location for groundwater development in the study.

2.1.1Geology of the Study Area

Akure south Local Government falls within the basement complex region of Nigeria. The studied area lies between latitude 12 ^{o} 04 ^{o} and 11 ^{o} 11 ^{o} W and 13 ^{o} 81 ^{o} and 14^{o}13 ^{o}. and is underlain by precambian basement complex rocks of South Western Nigeria.Several part of Africa is underlain by crystalline basement complex rocks. The major types of rocks in Akure are granite rocks and charnokite.

The granite rocks which are member of the older granite suit occupy about 65% of the total area of Akure. Three principal petrographic varieties are recognized, the fine-grained biotite granite, medium to coarse grained, non-porphyritic biotite – hornblende granite and coarse – porphyritic biotite- hornblade granite.

The classification is based largely on the textural characteristics. Also three main textural types of charnockitic rocks are also distinguished in Akure.These are the coarse-grained variety, massive fine grained and the gneissic fine-grained types. Unlike most of the older granite, the charnokite rocks do not occur in form of smooth rounded boulders and only a few low hills all forming oval to sub-circular and elongated bodies.

The charnockitic rocks appear to have three modes of occurrence in the area, the first occurrence is within what seems to be the 'core' of the granite rock as exemplified by Akure body and few smaller bodies.The second is along the margins of the granite bodies as seem in Ijare and Uro Edemo-Idemo charnockitic bodies. The first two modes of occurrence are mainly shown by the coarse-grained charnockitic variety.

The last mode of occurrence is represented by the discrete bodies of the gneissic fine-grained charnockitic rocks within the country gneisses as seen in Ilara and also near Iju and Emirin villages.All the charnockitic in the region are dark-greenish to greenish-gray rocks with bluish quartz are greenish feldspars (V. O. Olarewaju, 1997).

2.1.2 Hydrogeology of the Study Area

The major river in Akure in Ondo State is Ero River,this river originates from Igbara Oke road, about 16-18km distance to Akure town.Osun River is the major source of water runoff in Akure town, there are other smaller rivers such as Owuruwu River which is about 60m distance from Apex Nursery and Primary School, Oba Adesida, which is the Ves location.

This river flows to meet Osun River at Akure road, the other rivers such as Otenre River, Omi Atamo, are smaller rivers that serve as runoff in the town; they meet Osun River at a point known as Osun Amon.Osun River flows from the Eastern part to Western part of the town and then flows to Ise town to meet a bigger river called Ogbese in Ondo State.

2.2Result and Discussion

The interpretation of field resistivity data are in terms of resistivities and dept to the bedrock and interfaces across which a strong electrical exists.The analysis and interpretation of the surveyed data shows four geoelectric layers. These layers are top soil which consists of the various rock types from clayey sand to sandy clay to compact sand.

The second is the fresh/highly resistive basement. The fresh basement is characterized by high and infinite resistivity value and could not be contended on for groundwater, but the weathered zone and fractured basement which have lower resistivity value constitute good water zone

2.2.1.Geoelectric Section

The quantitative interpretation of the VES data resulted in the production of numbers of geoelectric section. The section provides composite information along lithologic depth, the geoelectric section revealed four subsurface geoelectric layers.The top layer which consists of (clayey sand and sandy clay) has resistivity value ranging from 70^{0}hm-m to 580^{0}hm-m, the maximum layer thickness is 3.0m.

The top soil contributes to the development of groundwater, this layer is called the layer of aeration, and the water in this layer is called sub-surface water or zone of aeration. This zone is subdivided into three namely; soil water, intermediate belt and capillary belt.

The water that infiltrate into the soil from precipitation and in general ranges to all water present in the sub soil, or (in lithosphere). It may be evaporated from the soil, may be absorbed by plant root (soil water) and then transpired or may percolate downward to groundwater reservoir (intermediate). It occurs in a zone extending from the ground surface to the lower limit of porous water bearing rock formation (capillary) and designated s zone of the rock fracture.

The difference in compaction of the clayey sand is responsible for the variation in the resistivity values. The resistivity of the second layer (Weathered zone) ranges from 30^{o}hm-m to 193^{o}hm-m while the thickness varies between 3m to $15.0m^{2}$. The third layer is the fractured basement which has layer thickness varying from 17.5m – 29m with resistivity value ranging between 90^{o}hms-m to 240^{o}hms-m. The layer will be good for groundwater accommodation if the fractures are interconnected and permeable.

The fresh basement which is the fourth layer is characterized by high resistivity value up to 6650^{o}hm-m.

The fresh basement is made up of infinitely resistivity rock in all the stations which form the bedrock.The rock in this zone is hard, with no permeability and no water bearing. In fresh, non-fractured rock, the porosity is often less than 2%, as a result, run off is high and infiltration rate is very low in this zone. The geoelectric section shows that the depth to the bedrock varies across the sounding station.

2.2.2. Overburden Layer

The thickness of the overburden is an important hydrogeologic consideration in groundwater development in the basement terrain (Ajayi & Hassan 1990, Olorunfemi & Idonigie, 1992). Because water gets into the saturated zone through the overburden , the thickness of the overburden ranges from 23.30m to 36.60m in the study area. The variation in the overburden is due to degree of composition.

2.2.3. Weather Layer.

The weathered zone thickness shows the thickness of the weathered layer beneath in all the sounding station established across the study area, with VES 5 having the highest of thickness of about 13m and VES 1 having the lowest with about 2m.deriving from this, the thickness of the weathered layer here has, is sufficient enough for groundwater accumulation and therefore recommended for location of a borehole. The variation in the weathered layer is due to the degree of weathering.

2.2.4. Fractured Layer

The weathered layer thickness shows the thickness of the fractured layer beneath in all the sounding stations established across the study area, with VES 1 having the higher thickness of about 15m and VES 2 having the lowest with about 1.80m and the variation of this layer is due to degree of fracturing.

VES 5 and VES 1 are the location that will be recommended for groundwater, because they have the highest thickness of both weathered zone and fractured zone respectively which are good for groundwater accumulation.

VES 5 is recommended as priority location for sitting borehole, because it has thick sequence of both weathered zone and fractured basement, which are good for groundwater accumulation. If the fractured are interconnected and hence permeable, the thickness of the weathered zone in this section confers advantage on this over others.

The location will be good for optimum groundwater development, because of its availability in the study area; it will also be the only safe source of untreated water in Akure and also the cheapest source of good quality water supply, and its development can take in small crement rather than with relatively large scale financial investment which is the case of dams.

VES 5 has an advantage over VES 1, because the cost of drilling through VES 5 (weathered zone) will be cheaper than drilling through VES 1 which is of harder rock (fractured basement) and more difficult to drill.

VES 1: This location will be good for groundwater development if the fractures in this zone are interconnected and have permeable. The problem with this section is that to drill through fractured basement is very difficult and hard, it can damage the drilling bit.

VES 2: In this location, groundwater yield could be high bit, will not be up to that of (VES 1 and VES 5) so it can not be recommended for groundwater because the dip of the location and also the thickness of the area could affect its yield.

VES 4 will produce minimum groundwater yield, because of its dip and thickness of weathered zone which is small, it ranges between 1.70m to 7.0m.

VES 3: This location has the lowest thickness and the lowest probable groundwater yield, this location could be poor for groundwater yield and it is not recommended because of the thickness and dip as it can be seen in the geoelectric section.

3. Conclusion

The result of a quantitative interpretation of the VES data obtained in a geophysical survey over part of Akure, on a location opposite Apex Nursery and Primary School, Oba Adesida Road, Akure in Ondo State. The interpreted results obtained from the study area are represented by a geoelectric section which shows the sequence and relationships between the subsurface lithologies.

The weathered layer and the fractured zone have been identified as the aquiferous in the area. The weathered layer is thicker in VES 5 and lowest in VES 1, while the fracture basement is thickest in VES 1. The 2 VES stations have been identified as the most suitable location for groundwater development in the area, with VES 5 being more prolific than others.

4. References

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Table 1: Summary of Layer Thickness of Resistivities

Town	Location	VES No	Curve Type
AKURE	AKURE, 11, Opposite Apex Nursery and Primary School, Oba Adesida Road, Akure.	1	HA
		2	HA
		3	H
		4	H
		5	HA

Table 2: Resistivity in Sounding Station

VES Number	Thickness			Resistivities (Ohms-m)				Overburdened Thickness-EH(M)
L	h1	h2	h3	e1	e2	e3	e4	
1	1.20	2.98	19.08	580	193	613	5400	23.76
2	3.00	8.30	11.10	500	167	2470	6650	22.40
3	1.70	2.55	-	265	80	2565	-	4.25
4	1.15	6.70	-	170	30		-	7.85
5	1.80	14.58	19.58	570	63	594	2660	36.66

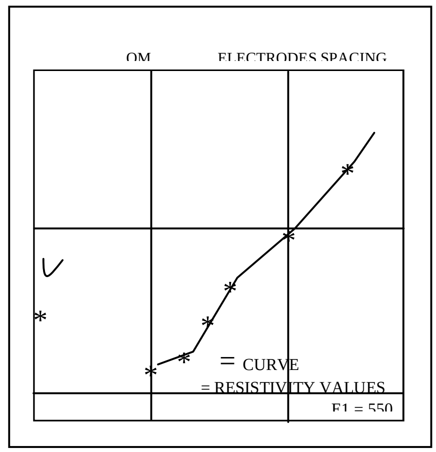
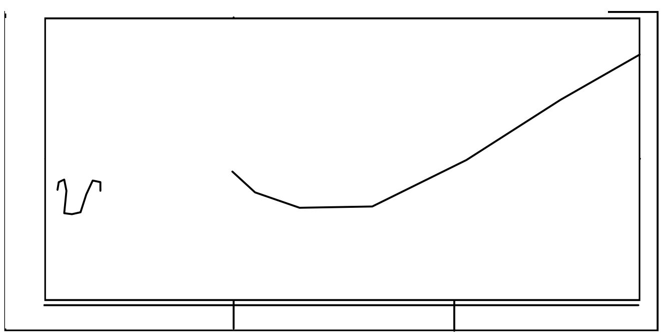


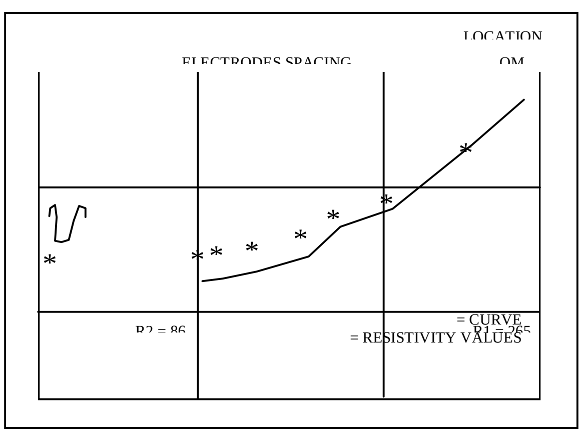
Table 3: Classification of VES Curves

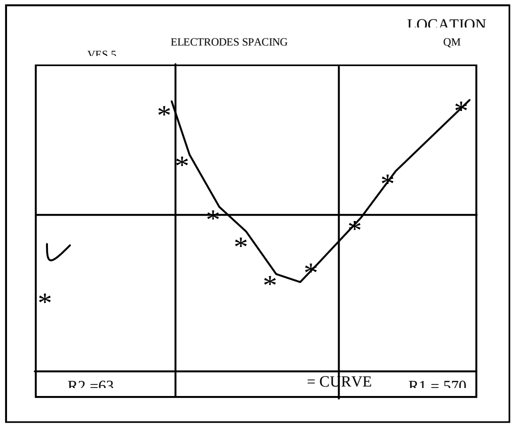
VES Station	Thickness of 1st Layer (m)	Thickness of 1st Layer (m)	Thickness of 1st Layer (m)	Depth of Bedrock (m) Overburden Thickness	Weathered Layer Thickness (m)	Resistivity of the Weathered Layer (ohm-m)
1	1.70	2.98	19.08	23.70	19.08	613
2	3.00	8.30	11.10	22.40	11.10	247
3	1.70	2.55	-	4.25	2.55	86
4	1.15	6.70	-	7.85	6.70	30
5	1.80	14.58	19.00	35.38	19.00	594

ELECTRODES SPACING QM

VES 1







LOCATION:AKURE