

# **SUBSURFACE INVESTIGATION FOR EFFECTIVE WATER RESOURCE DEVELOPMENT: A PANACEA TO PROBLEM OF WATER SUPPLY SERVICES IN THE BUILT ENVIRONMENT OF THE NEWLY CREATED AREAS IN ANAMBRA, NIGERIA**

## **ABSTRACT**

The creation of new Local Government Areas (LGA) in Nigeria has brought about problem of water scarcity due to population increase and consequent increase in the construction of residential buildings; especially in the south east in the recent time . Ihiala LGA is a case under study. Since the creation of Ihiala local government area in Anambra State of Nigeria, there is the need for underground water resource development for effective water supply system towards sustainable housing in the area due to population increase, and development of more residential buildings. By using Vertical Electrical Sounding (VES) technique in geophysical survey of the subsurface, it was discovered that there are about six litho-logical units in the area. The subsurface lithology, aquifer depth and their dispositions, were probed using Abem Tetrameters 300 SAS and Geographic Information System equipments to identify the resistivity of the formations. In the area, sand stone deposit is prominent at the upper levels between 3 to 27 meters. Aquifer depth is located within 75 to 120 meters. The saturated sand stones significantly occur within the 3<sup>rd</sup> and 5<sup>th</sup> layers of the litho-logical horizons. The aquifer is mostly semi confined, and composed of sand, silty sand and sand-stone mineral aggregates. Subsurface water resources exploitation using borehole facility in the area therefore should reference these discoveries for easy and sustainable underground water resource development, to meet the people daily need for good water in the study area.

**Keywords:** Ihiala Local Government Area, Sedimentary Basin, Vertical Electrical Sounding, Aquifer, Water Supply System, and Residential Buildings.

## **INTRODUCTION**

Local government creation in Nigeria brought about attendant population increase which called for construction of more residential buildings and the consequent need for underground water resources development, for economic and domestic purposes in the built environment; since the available water is no longer enough in these areas. Water borehole drilling failures abound in most of these new local governments, due to lack of appropriate exploration information; hence the need for geophysical investigation of their sub-surfaces. Besides, open channel and unconfined underground water sources in most of these areas in the south eastern Nigeria especially suffer pollution; characterized with objectionable taste to food, and unsuitable for most industrial uses (Onunkwo and Ikechukwu, 2018 ; Onunkwo et al, 2017). Hence, the need for effective geophysical investigation of their sub-surfaces for sustainable underground water resource development.

In this work, effort had been made to probe the sub-surface litho-logy, aquifer depth and dispositions, using Abem tetrameters 300 SAS and geographic information system equipments. Onyeagocha, 1980 observed that the success of the exploitation of underground water resources depends on the effective probing of the subsurface litho-logy, by

identifying the resistivity of the formations; hence aquifer disposition.

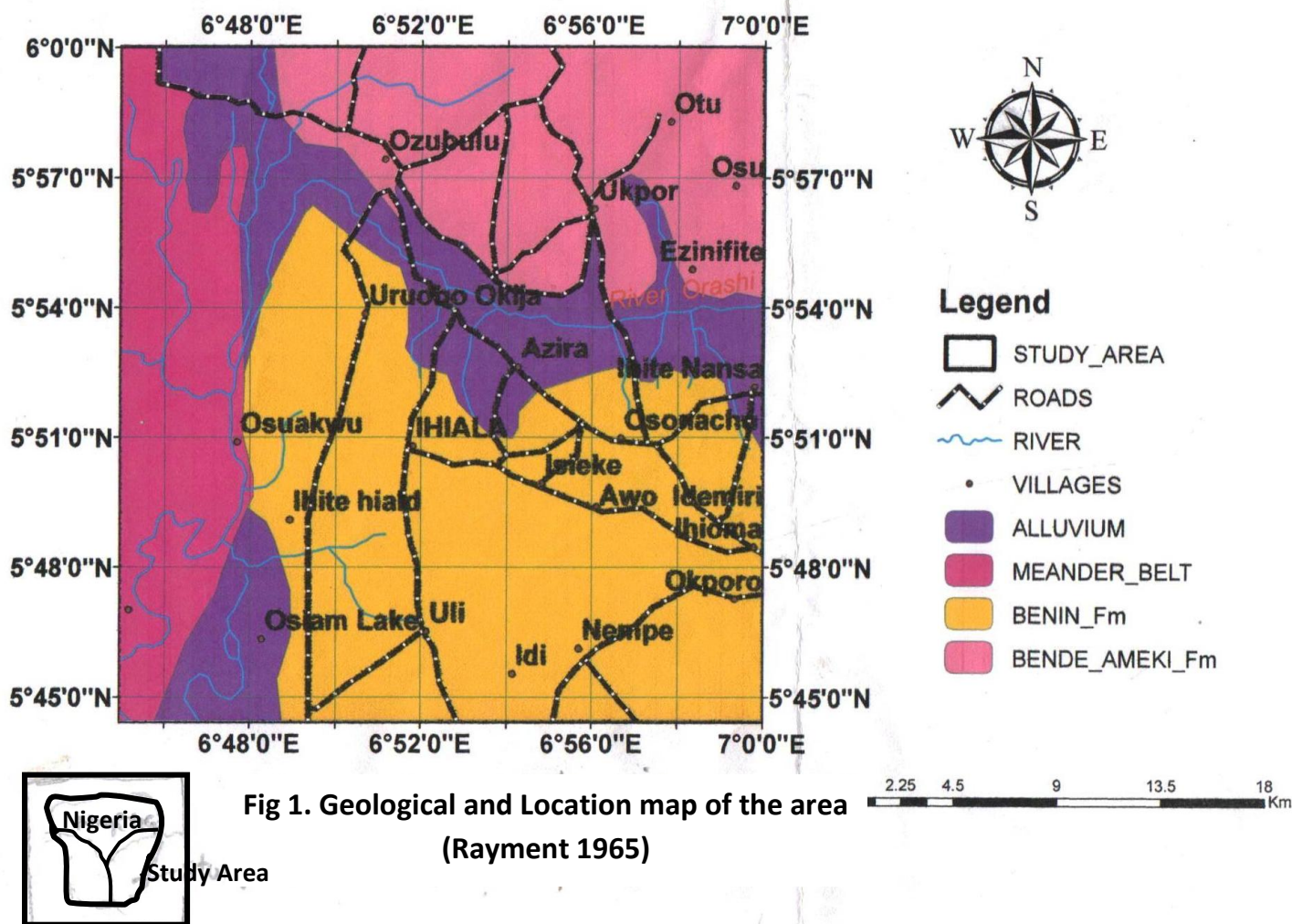
UNDER PEER REVIEW

The area is Located within Anambra sedimentary basin of the south

UNDER PEER REVIEW

eastern Nigeria. It is Bounded by longitude 6° 45E to 7°E and latitude 5°

**GEOLOGY AND LOCATION MAP OF THE AREA**



45N to 6°N. The drainage pattern is dendrites, typical of sedimentary rock with uniform resistance and homogeneous geology (Short and Stauble, 1967). The area is of tropical climate and experience two air masses - Equatorial maritime air mass associated with the rain bearing wind which is a South west wind from the Atlantic ocean blowing around March to September (Iloeje, 1981); while the dry season trade winter comes from Sahara desert around October to February causing dryness. According to Uma and Egboka, 1986; the area it is over Lain by Benin formation and underlain by Ameki of miocene age. The geological and location map is shown in Fig 1, while the stratigraphic succession of the area is shown in Table 1.

**TABLE 1. THE STRATIGRAPHIC SUCCESSION OF THE AREA**

Age	Formation
Miocene	Benin formation
Paleogene	Ameki Formation

**RESEARCH METHOD AND MATERIALS**

Vertical electrical sounding technique (VES), using tetrameter 300 SAS according Akanyeme (2012) was carried out preliminary in line with schlumberger approach to identify the litho-logical variations as well as deduce the aquifer types and depths in the built environment. The result was displayed for observation as shown in Tables 2 (a-h). Aquifer litho-logical units were shown in Fig 2, while prospective aquifer nature is shown in Table 3.

**Table 2 (a-h) Okija (A)**

<b>Ves</b>	<b>Thickness (M) VES 1</b>	<b>Litho-logical Description</b>
1.	0-1.4	Sandy top soil
2.	1.5 - 57	Silty sand
3.	58 - 78	Sand
4.	79 - 90	Sand with clay lenses
5.	91 - 111	Sand stone
6.	112 - below	Silty sand

**Ezinifite (B)**

<b>Ves.</b>	<b>Thickness (M) VES 2</b>	<b>Litho-logical Description</b>
1.	0 - 6	Sandy top soil
2.	7 - 15	Slity sand
3.	16 -33	Sand

4.	34 - 70	Sand with clay lenses
5.	71 – 105	Sand stone
6.	105 – below	Silty sand

### **Isieke (C)**

<b>Ves</b>	<b>Thickness (M) VES 8</b>	<b>Litho-logical Description</b>
1.	0 – 9	Top soil
2.	10 – 21	Sand
3.	22 - 27	Clayey Sand
4.	28 – 75	Sand Stone
5.	76 – 118	Sand stone
6.	119 – 128	Sand Stone
7.	129 – below	Clayey shale.

### **Azira (Okija) (D)**

<b>Ves</b>	<b>Thickness (M) VES 3</b>	<b>Litho-logical Description</b>
1.	0 – 9	Top soil
2.	10 – 30	Sand stone
3.	30 - 55	Silty Sand
4.	55 - 85	Sand
5.	85 – 113	Sand stone
6.	114 – 122	Transition
7.	123 –below	Clay base

### **Ihiala (E)**

<b>Ves</b>	<b>Thickness (M) VES 4</b>	<b>Litho-logical Description</b>
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1.	0 - 9	Sandy top soil
2.	10 – 24	Shaley sand stone
3.	24 – 61	Sandy clay
4.	61 – 75	Sand
5.	75 – 94	Sand
6.	94 –below	Clay

### Osaka (F)

Ves	Thickness (M) VES 5	Litho-logical Description
1.	0 – 2.8	Sandy top soil
2.	2.9 – 46	Sand stone
3.	47 – 98	Sand
4.	98 – 107	Sand stone
5.	108 – 121	Sand
6.	122 –below	Shale

### Ihitte (G)

Ves	Thickness (M) VES 7	Litho-logical Description
1.	0 – 5	Sandy top soil
2.	6- 40	Sand
3.	41 – 90	Sandy clay
4.	91 – 98	Sand
5.	99 – 119	Sand
6.	120 –below	Shale base

### Osuakwu (H)

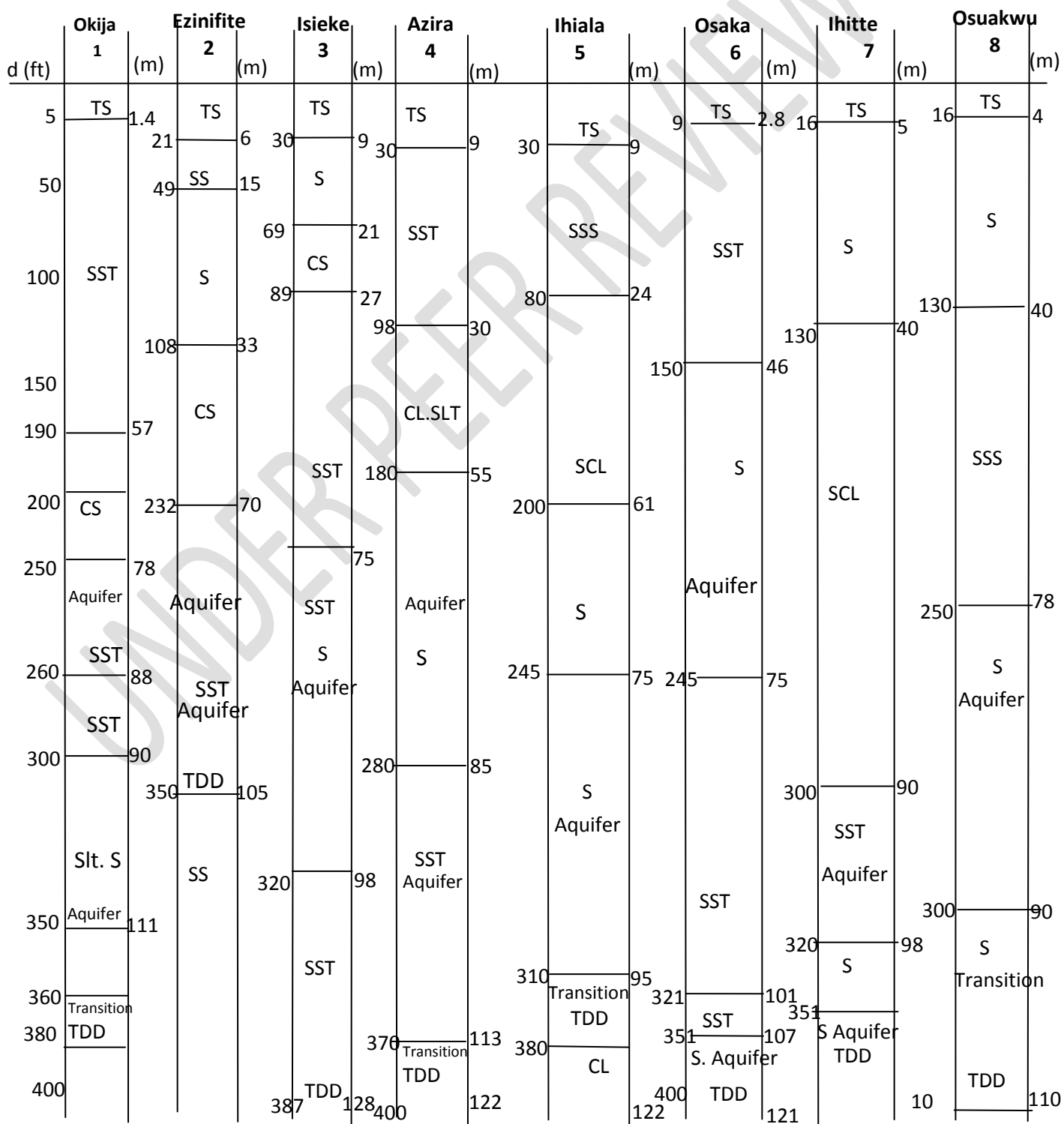
Ves	Thickness (M) VES 6	Litho-logical Description
1.	0 – 4	Sandy top soil
2.	5 -30	Sand
3.	31 – 57	Sandy clay

4.	58 – 90	Shaley Sandstone
5.	91 – 110	Sand
6.	111 – below	Clay base

**Table 3. Prospective Aquifer Nature (From VES Results)**

Us1	Location	Depth to Water Table (M)	Number of Layers	Aquifer Materials	Overlying Materials	Aquifer Type
1	Okija	78	6	SST & Slt.S	CS	Semi Confined
2.	Ezinifite	71	6	Sst	S.Cl	Semi confined
3.	Isieke	75	7	Sst	Sst	Confined
4.	Azira	55	7	S & Sst	Cl.Slt	Semi Confined
5.	Ihiala	75	6	S	S	Semi Unconfined
6.	Osaka	46 & 107	6	S & Sst	Sst	Confined
7.	Ihitte	90	6	S & Sst	S.Cl	Semi Confined
8.	Osuakwu	78	6	S	SSS	Semi Confined

**Legend:** Slt.S – Silty Sand, S.Cl – Sandy Clay, Cl.Slt – Clayey Silt, S – Sand, Sst – Sandstone, SSS – Shaley Sandstone, CS – Clayey Sand, and TDD – Total Drill Depth.



**Fig 2. Litho-logical Units**

## **DISCUSSION AND FINDINGS**

Borehole drilling practitioners in Ihiala area should observe that sand stone deposits are dominant at the shallow depth of about 3 to 27 meters. The range of aquifer depth is about 75 meters. Three to seven Litho-logical units abound in the area, and aquifers significantly occur in 3<sup>rd</sup> to 5<sup>th</sup> litho-logical layers. The aquifer content is made of sand, silt and sand stone. The average drill depth is 122m as was observed by Onyeaocha, 1980; and the aquifer is mostly semi confined. The semi confinement is marked at the Upper level of the aquifer by sandy clay to sand stone, while the base is typically shale to clay layers. Unconfined aquifer is insignificant in the area. For effective groundwater exploration and exploitation in the built environment, the work is helpful as it showed the aquifers dispositions and litho-logy of the area, as well as their respective depth.

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