Investigating Rock Electrical Properties of Anambra River Basin, Using Geophysical Technique

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ABSTRACT: *Geophysical Investigation of Anambra South River Basin of Nigeriahas being studied This research work presents the methods of exploration with particular reference to the Electrical resistiviy method as used in determining the hydrogeology of some parts of Anambra South. Vertical Electrical sounding (VES) is utilized using the digital electronics Device, ABEM 300B Tetrameter with Schlumberger array. The hydrogeological provinces of the study area is: The Eastern lowland and the Western upland. The former is underLaid by the Imo formation while the letter is under laid by Ameki /Nanka and Ogwashi-Asaba formations. Results from data analysis and interpretation shows that clay and sand Formations are the predominant lithology within the study area. The aquiferous formation Lies within sand, clayey sand and sandstone lithology. Sands and sandstone appear to Have large thickness across the horizons and locations, the thickness of the horizons Varies between (1.20- 122.00) meters.*

Keywords:- *Anambra, River-Basin, Electrical, Resistivity, Lithology, Horizon*

I. INTRODUCTION

A river basin is the portion of land drained by a river and its tributaries when the river overflows. It encompasses the entire land surface dissected and drained by many streams and creeks that flow downhill into one another, and eventually into one river. The rock characterization or Litho logy of the portion of land drained by the river is studies in this work by adopting the concept of geophysical methods. This survey technique involves looking into the ground to find detailed of subsurface stratigraphy of the areas of interest, (7), Technologies used for Geophysical methods, includes, Geodesy, Seismic methods, well logging, Electromagnetic, Electrical methods e.tc (6). The choice of geophysical technique adopted for investigation depends upon the contrasting properties of subsurface rocks, nature of the terrain, cost consideration, possibility of direct Penetration and homogeneity within a particular formation(1,2).In general, greater probe spacing yields greater depth of investigation, but at the lost of sensitivity and Spatial resolution {3}. The lithology of a rock is a description of its composition (what it is made of) and Texture. (1, 2, 9). This description includes the colour, structure, mineralogy, composition and grain size. Geophysical methods measure the physical properties of rocks, seismic velocity; resistivity etc. to use Geophysical method to map lithology, there has to be some relation between the lithological parameters and the physical property of the rock. Low-resistivity areas correspond to clay layers and high resistivity Areas (greater them 10002m) corresponding to sand and gravel sands.

II. LOCATION OF STUDY AREA

The locations of study area are all within Anambra State near Enugu. The ApkalaguNsugbe community is located at about 2km NE of Ofianta. Along Aba road at the community central square is located a sitein thisResearch work. The OffiantaNsugbe is within Nsugbe main town which is near Umuleri and Okuocha. Other locations include; Odida central school Nrewichi and Ezekwabor community Otolo and Nnewi.

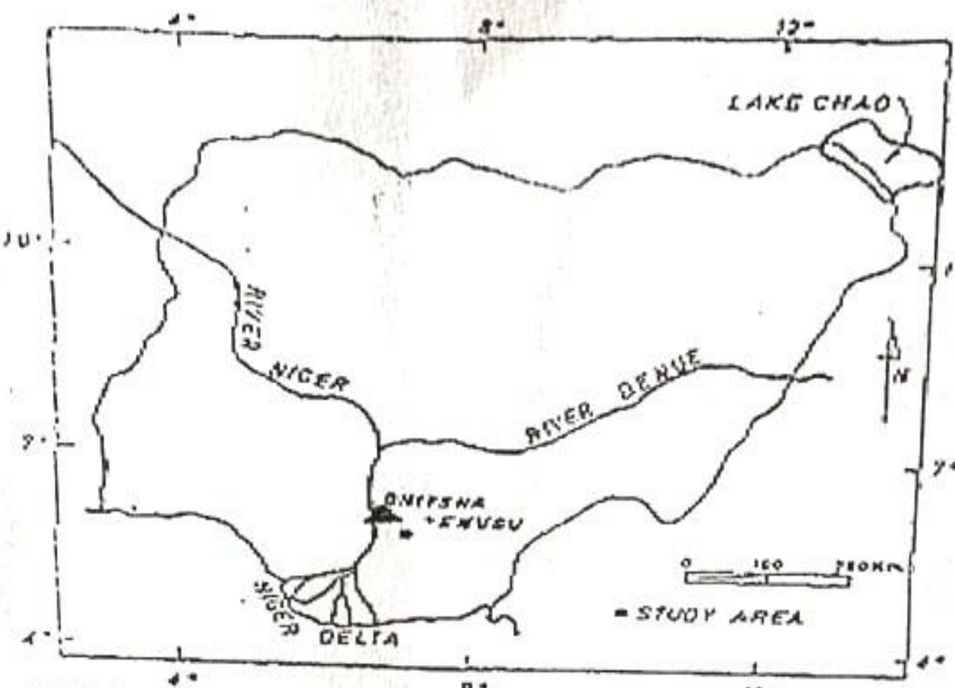


FIG. 2 The location of the study area (A)

III. GEOLOGY OF THE STUDY AREA

I. Anambra sedimentary Basin is bounded on the East by the Benue trough. The Abakaliki basin lies of the Benue tough which is bounded in the East by Niger or Nufe basin (the sedimentary in this basin directly over the buried basement complex which are exposed further west). In the southern part of the Benue trough and Anambra Basin is the prolific Niger Delta Basin. Ajahi sandstone may be encountered on the surface and in deep borehole at various place and location within Anambra Basin. Five known tertiary formations are found in the down dip Eastern part of the Basin. Nearly all the formation grade laterally into the Benin Basin with phase changers, these formation include
II. I. .Imo shade formation (Paleocene-Eocene)
III. 2. Ameki formation (Eocene-Oligocene)
IV. 3. Ogwashi-Asaba formation (Oligocene-Miocene)
V. 4. Benin formation (Miocene-Pleistocene)
VI. 5. Marine Deltaic Alluvium formation
VII. It is however, very important to note that out of the tertiary formations listed above, only two (Ogwashi-uku)
VIII. Asaba and Ameki formations) occur within the study area.

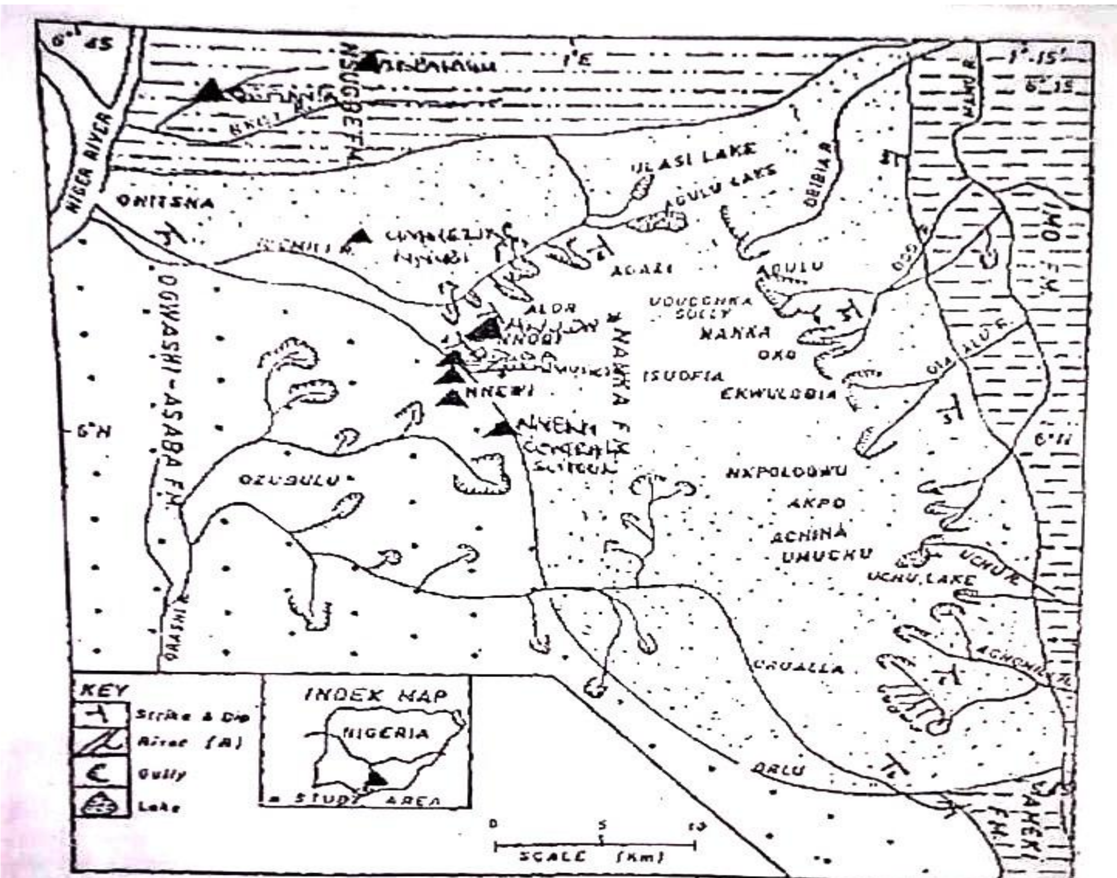


FIG.2 The geology of the study area (A)

IV. HYDROGEOLOGY OF THE STUDY AREA

The study area is underlain by sediments of non-maritime, and shallow marine origin. The Ameki formation (mostly shallow marine sediments), the Ogwashi-Asaba formation (non-marine sediments) is the youngest of the two formations. The study area land forms are the Western uplands and are on the basis of lithology (8).

They are regarded in hydrogeological quarters as medium to high prolific aquifer. The Western uplands are covered by the Ogwashi-Asaba formation and Nanka sands of Ameki formation. The Nanka sands are interspaced by white pink purple streaks/thick bounds of clay iron pain, dark grey shale and thin of gravel mixed with ironstone pebbles. The sand unit forms the main sources of surface and groundwater resources of the area under study. Borehole drilling depth increases generally with topography. In Ameki formation, depth however increases as one ascends in the Northern direction towards Nnoka near Adazi-Ani where drilling depth is up to 1000ft (305).

V. METHODS

Geological survey is employed to look into the ground and find detailed subsurface stratigraphy beneath the area. This method makes use of variations in the electrical properties of rocks and minerals. The major field equipment used in this investigation is a digital electronic device, ABEMSAS (Signal Averaging System) 300B Tetrameters with its booster.

Various soundings for festivity variations were taken using the Schlumberger electrode array. The type of configuration used is determined by the arrangement of the current and potentiometer (5). Two current electrodes such that in the theory, the introduced current should be, generating at greater depth. Second pair of potential electrodes is used to measure the potential difference developed. The emanating measured resistivity is called the apparent restively (ρ_a) For Schlumberger array, the apparent resistivity is given as

$$\rho_\alpha = \frac{\pi(\frac{s^2-a^2}{4})}{a}\frac{\Delta v}{i} \text{-----------------------} 1.0\ (4)$$

Where $\Delta v = change\ in\ potential$

I= current introduced, $\propto = Potential\ Electrode\ Separation\ distance$

S = Half the distance of Current Electrode separation.

It follows that the Geometric factor "K" is expressed as

$$K = \frac{\pi(\frac{s^2-a^2}{4})}{a} ------------- 2.0$$

Rewriting equation 1.0 in terms of "K" we have

$$\rho_\alpha = k\frac{\Delta v}{i} = kR ----------- 3.0$$

Where, R = resistance opposing flow of electrons. Other symbols define their usual meaning. From equation (2.0), the geometric factor can be calculated. The apparent resistivity is gotten as a product of the geometric factor and the corresponding resistance recorded at the display unit of the measuring instrument (Terrameter).The field and model curves are obtained by plotting (ρ_a) values against the values of (S). Standard resistivity tables and the resulting output data from the software (1_P2 Win) input data are employed to make the Lithological inference.

VI. RESULTS

The results gotten from this work show that the study area is dominated with clay and sandstone formations. Table (1-5) gives vivid details about the geoelectric layers and the inferred Lithology across the different horizons probed.

The corresponding Vertical Electrical sounding ((VES) Curves and the horizontal images from each location(site) are presented as fig (3-6).

Table 1.0: Geoelectric layering at Odida central school, Nnewichi

Geoelectric layers	Depth (m)	Thickness (m)	True Resistivity(Ωm)	Inferred Lithology
1.0	0-4.0	4.0	8071	Topsoil Lacerate
2.0	4.0-7.0	3.0	1146	Sandy, Slit
3.0	7.0-12.0	5.0	676	Clayey Sand
4.0	12.0-48.2	36.2	1750	Dry Clay and Sand
5.0	48.2-112.0	60.0	854	Clayey Sand Aquifer
6.0	112.0		1007	Sand Clay

Table 2.0: Geoelectric layering at AkpalaguNsugbe

Geoelectric layers	Depth (m)	Thickness (m)	True Resistivity(Ωm)	Inferred Lithology
1.0	0-1.20	1.20	95.0	Topsoil Lacerate
2.0	1.0-15.00	13.8	190.0	Sand. Clay
3.0	15.00-75.00	60.00	475.0	Clay Sand Aquifer
4.0	110.0		142.5	

Table 3.0: Geoelectric layering at Abba community Nsugbe

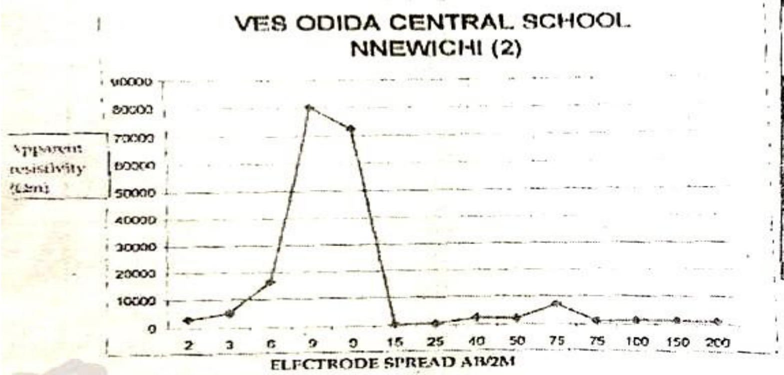
Geoelectric layers	Depth (m)	Thickness (m)	True Resistivity(Ωm)	Inferred Lithology
1.0	0-1.60	1.60	340.00	Topsoil
2.0	1.60-4.60	3.00	102.00	Clay
3.0	4.60-130.00	25.40	1020.00	Sand Clayey
4.0	130.00-65.00	45.00	408.00	Sandy Clay Aquiferus
5.0	65.00-98.00	33.00	29.00	Shale, Clay
6.0	98.00-130.00	32.00	112.24	Clay Sand
7.0	130.00		4489.6	Shale, Sandy

Table 4.0: Geoelectric layering at Ezekwabor Community, Otolo, Nnewi

Geoelectric layers	Depth (m)	Thickness (m)	True Resistivity(Ωm)	Inferred Lithology
1.0	0-1.55	1.55	2527	Lateritic Topsoil
2.0	1.55-5.86	4.31	2098	Salt and Clay
3.0	5.86-38.08	32.22	5178	Sandstone (Dry)
4.0	38.08-101.67	63.59	2992	Clay and Sand Stone
5.0	101.67		1134	Clayey Sand Stone

Table 5.0: Geoelectric layering at Nnewichi central school, Nnewi

Geoelectric layers	Depth (m)	Thickness (m)	True Resistivity(Ωm)	Inferred Lithology
1.0	0-1.9	1.9	575	Topsoil
2.0	1.9-5.7	3.8	336	Sandy and Clay
3.0	5.7-61.0	55.3	7226	Sandstone with Clay
4.0	61.0-109.3	48.3	13168	Sand Stone Clayey Sand
5.0	109.3		6784	Sand Stone



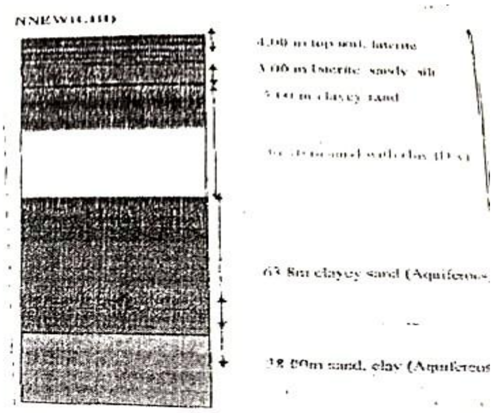
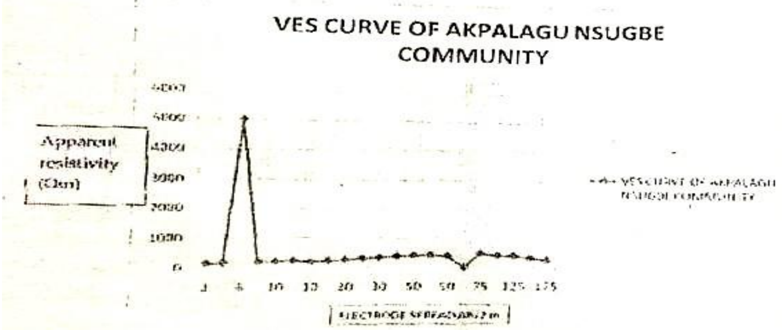


Fig 3:VES field curve for Odida



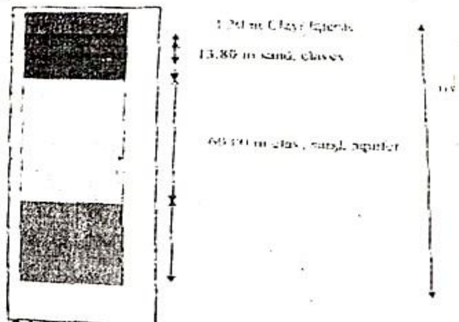


Fig 4: VES Curve for AKPALAGU

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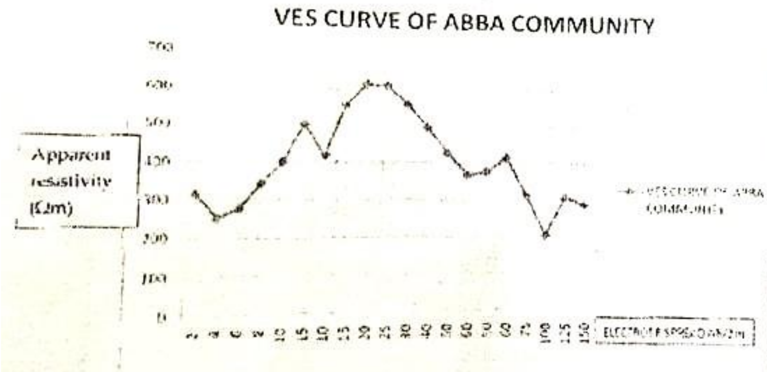


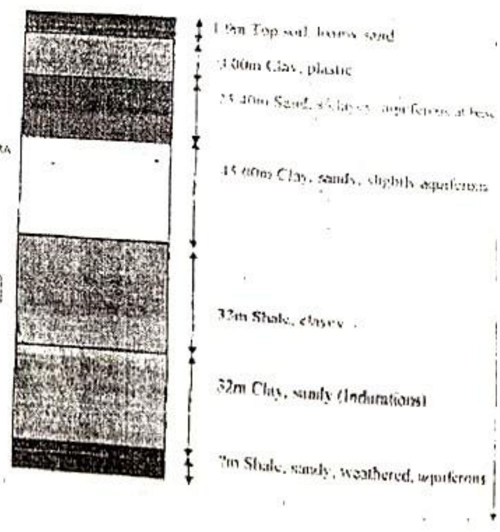


Fig 5: VES Curve for Abba Community

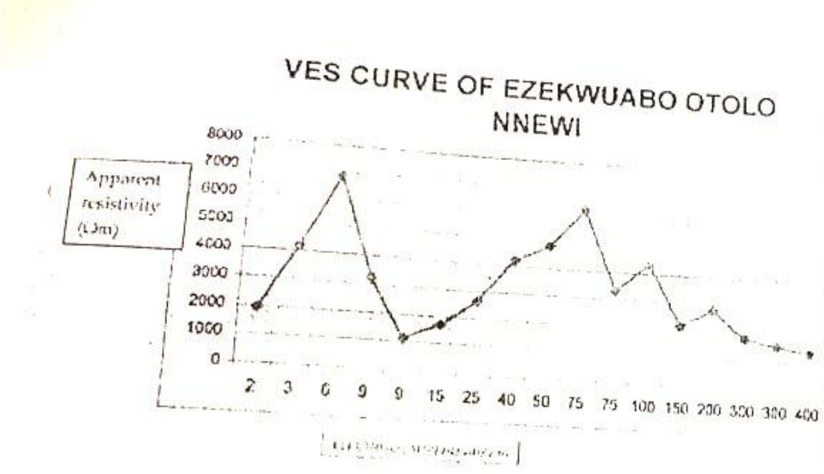
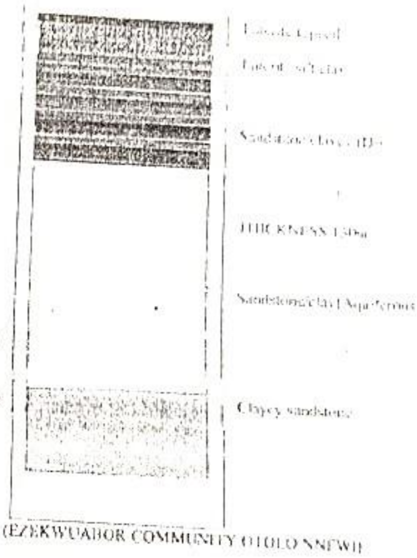
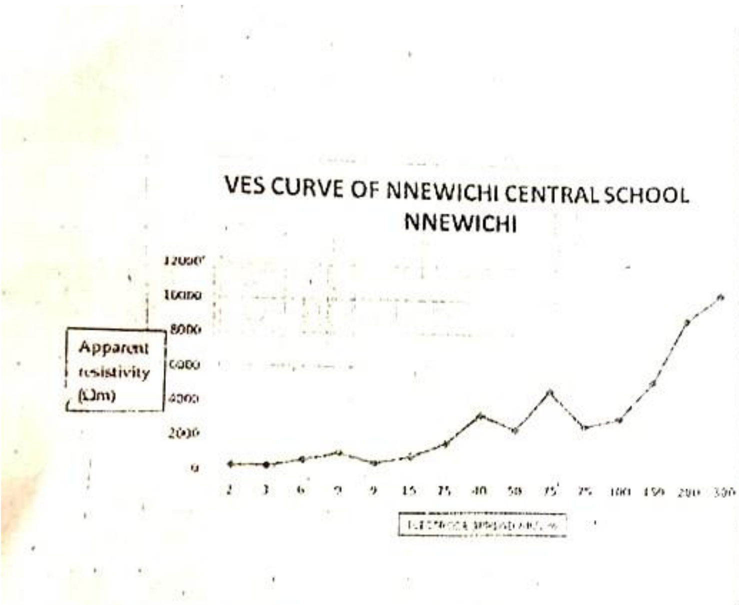


Fig 6:VES Curve for Ezekwabor Community





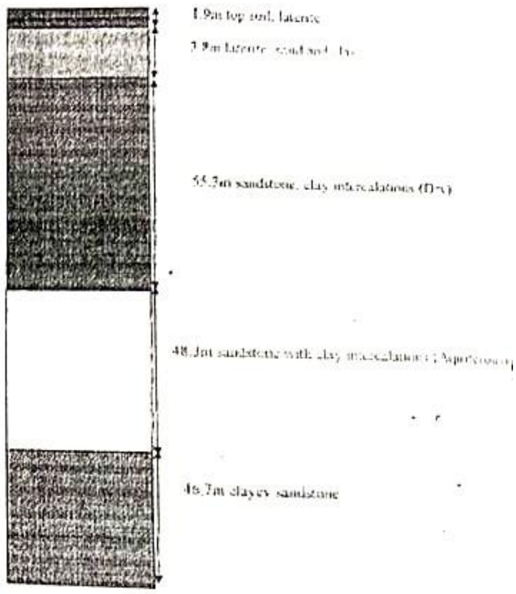


Fig 7.0 VES Curve for Nnewichi. Centre

VII. DISCUSSION

The geoelectrical section at Odida Central School, Nnewichi depicts a top soil of lateritic Lithology. The Second layer is silt while clayey sand lithology is inferred for the third and fifth layers. The fourth layer is dry sand, clay formation. Layer five holds good amount of ground water with a clayey sand interred lithology.

At AkalaguNsugbe, four geoelectrical sections are delineated. The topsoil (clay,laferite) has a resistivity of 95.002m. The lithology in this location are clay and sand or clayeysand. At Abba Community Nsugbe, the second and third are of clay lithology which is auriferous at base because of the sandy clay formation, we have shale and clay as inferred lithology for the fifth layer. Layer seven is of weathered rocks with a very high resistivity value.

The second, fourth, fifth and sixth layer may contain considerable large volume of water. At Nnewichi Central School, Nnewi, the topsoil and the second layers are lateritic sandstone with clay intercalation is the Inferred lithology for the other horizon at depth.

Ezekwabor Community Otolo, Nnewi deprets five geoelectric sections. The first layer is the topsoil, the second layer has silt lithology while the third, fourth and fifth layers are of sandstone and clay lithology.

VIII. CONCLUSION

Clays and sands formations are the pre-dominant Iithology encumbered within the study area. Aguilera's formntion within this sand lies within sand clay, clayeysand sandstone lithology. Thickness across the horizons varies between 120-122.00(m) with large thickness observed for sand and sandstone lithology.

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