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Electrical Resistivity Survey Forground Water At Eye Zheba Village, Off Bida - Minna Road

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Abstract: *The paper titled "Electrical Resistivity survey for ground water" at EL-HALAL Farms, covered an area of about 10km², located at Eye Zheba village along Minna-Bida Road, located on latitude 6° 00' and 6° 7' West and longitude 9° 3' and 9.10' North. As a result of water problem in Bida and its environs, the people living in this environment suffered a lot due to lack of portable drinking water and water for domestic use. A Geophysical survey carried out, employed the schlumberger Array method in which current were sent beneath the earth surfaces, this was done at various points and the data collected. The area revealed three lithological formations in some places while in some place five. With the lowest resistivity found to be 6.85 Ωm and the highest resistivity was 12,774.46 Ωm. The lithotogical formation includes the sandstones, clayey sandstones, sandy clay and ferruginised sandstone. Since this is a sedimentary area drilling is expected to be deep down to a depth of about 70-75m.*

Keyword: *Depth, Aquifer, Resistivity, and Geoelectric*

I. Introduction

Over the years, ground water becomes the most stable and successful source of water supply in most part of this country, Nigeria and Niger state in particular. Ground water is used by individuals, in their various houses and farms in large scale. Therefore there is need for serious geophysical survey of areas of interest before embarking on drilling either at various homes or farms (Dangana et al, 2009). This is to enable us to be very certain of very viable point in which drilling is/are going to take place, which will probably serve the year round with enough ground water. So there is need for geophysical survey for primary aquifers that will serve the purpose throughout the year, since ground water is not only feasible, but also the most source of portable water for urban and rural community farmers, especially in Minna – Bida area. The survey is also targeted at providing useful information which is to serve as reference point for various farms in the community. The survey is also aiming at delineating the geoelectric sequence beneath the sounding stations and determining the geoelectric parameter there in, so also the aquifer unit and their depth.

Electrical resistivity survey has found useful application in ground water investigation. These include bedrock delineation, saline water mapping, lithological boundary differentiation and determination of structural trends among others (Mallam, 2006, Emenike, 2001).

Description Of The Study Area

The area under study is Eyezheba farm andits environment. The farm is about six kilometer off Bida – Minna road to the East. The farm is about 10km², located on latitude 6°00' and 6°07'N and longitude 9°03' and 9°10'W. The area is sparsely vegetated, typical of savannah type comprising of trees with thrive back and thick grasses of average heights. The average rain fall is between 1200mm – 1300mm. The raining season spring before April to October, with so much rain recorded in August. The mean annual temperature is 31°C. About half of the landmass of Niger State is underlain by the Basement Complex rocks while the remaining half is occupied by cretaceous sedimentary rocks of Bida Basin (fig 1.) (Amadi et al, 2012).

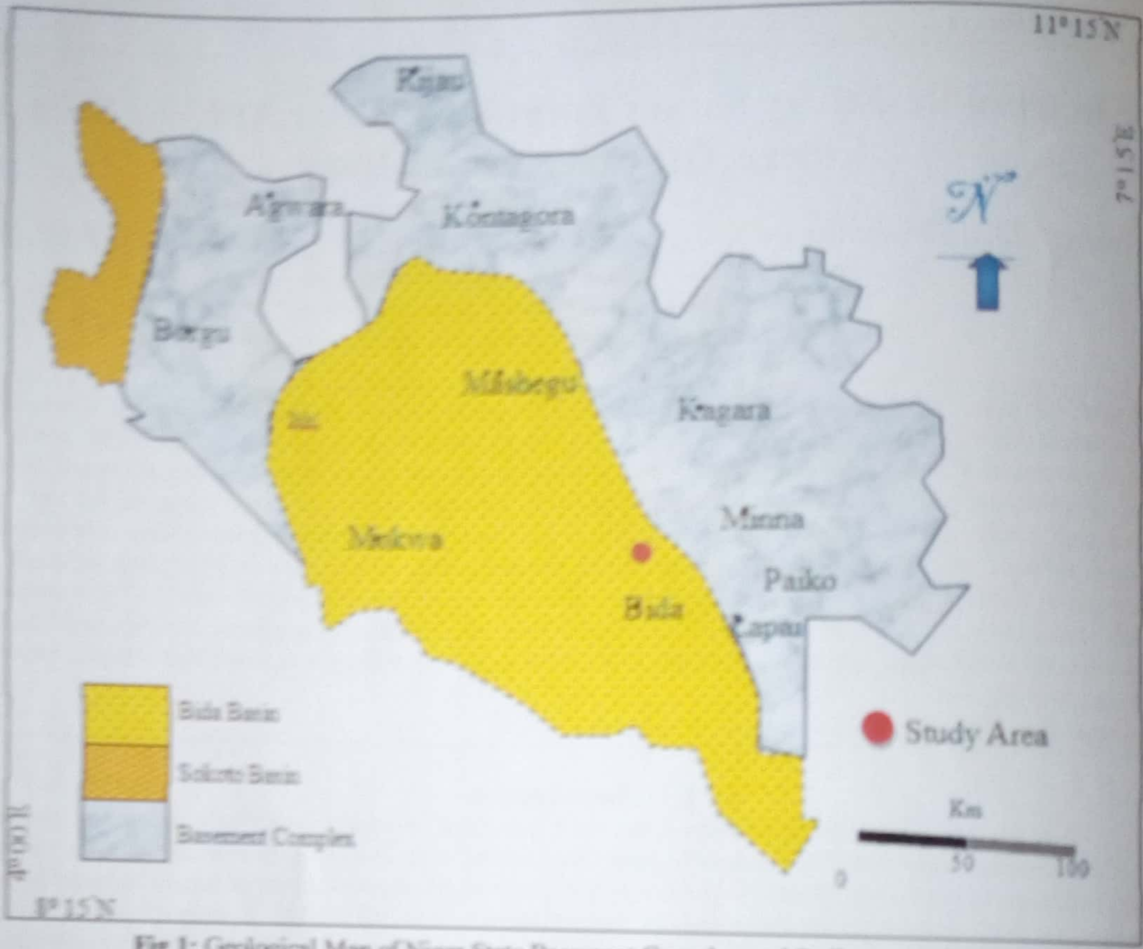

Fig 1: Geological Map of Niger State Basement Complex and Sedimentary Basins

Geology And Hydrogeology Of The Area

Bida, falls within the Nupe sandstones (Fig.1) which extends from the areas of Kontagora in the Northwest down to the area of Lokoja on Southeast. The basement on which the Nupe sandstones are laid has high relief as described by (Russ et al, 1957). This basement is overlain by rounded to subrounded course conglomerates clay-sand-pebbles admixtures. These sediments are conformably overlain by sandstones, subsidiary sandstones, fine conglomerate and siltstones known as Bida sandstones. The sandstones are succeeded by geolithic, dolithic and pisolitic ironstones which form a prominent break of slop along mesawalls in Bida area known as Sakpe ironstone formation. The ironstones are overlain by Argillaceous strata dominated by siltstones known as Enagi sandstones. The Enagi sandstones is overlain by upper ironstones known as Batati ironstones formation around Bida.

Generally the sandstones formation forms the basic aquifer in the sedimentary areas. This is represented in the Bida area mostly by the Bida sandstones. The basal sandstones could also be reached but the base of the sandstone is deep.

The siltstones of the Enagi sandstone, the clay of the Bida sandstone and the ironstones of the Sakpe formation provide very poor aquifer and should be avoided in order to provide quality water for domestic use.

II. Methodology

One of the most relevant geophysical methods of survey for mineral deposits and ground water prospecting is the electrical resistivity method (Dangana et al, 2003). This method determines the subsurface resistivity distribution of the ground, which can then be related to the physical conditions of interest such as lithology, porosity, degree of water saturation and presence or absence of voids in the rock. The method employs two techniques namely: the horizontal electrical profiling (mapping), which provides information on the lateral variation in resistivity of the ground and the vertical electrical sounding (drilling), which provided information on the variation in the resistivity with depth (Telford et al, 1980).

In this survey both Wenner and Schlumberger were used in data collection. The Wenner configuration was used for electric profiling, and the objective is to determine the resistivity variation laterally.

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The theory behind these spreads is well discussed in detail in sources such as Telford, (1989), Parasnis (1986) etc. In Wenner array method used for this investigation, the electrodes are uniformly spaced in a line. From the arrangement, we have that $r_1 = r_4$ and $r_2 = r_3 = a$. Thus the apparent resistivity is

$$\rho_a = \frac{2\pi a \Delta V}{I} \qquad 1$$

Where "a" is the spacing between the adjacent electrodes.

While in the other method, that is, schlumberger array, the current electrodes are spaced much further apart than the potential electrodes, from the first principles, then the apparent resistivity ρ_a is given by

$$\rho_a = \frac{2\pi \Delta V}{I}\left[\frac{1}{\frac{1}{(L-X)-l} - \frac{1}{(L+X)+l} - \frac{1}{(L-X)+l} + \frac{1}{(L+X)-l}}\right] \qquad 2$$

Simplifying, since (L – X)>>1, we have

$$\rho_a = \frac{\pi}{2l}\frac{(L^2-X^2)^2}{(L^2+X^2)}\left[\frac{\Delta V}{I}\right] \qquad 3$$

Since this is often used symmetrically, X = 0, in which case

$$\rho_a = \frac{\pi L^2}{2l}\left(\frac{\Delta V}{I}\right) \qquad 4$$

where L = half the separation of the current electrodes, l = half the distance of the potential electrode, V = potential difference measured and I is the current passed by the instrument, and X is the distance between the center of the spread to the midpoint of the potential electrodes we also find that r_1 = (L - X) - L, r_2 = (L + X) +L, r_3= (L-X) +L and r_4 (L+X)-L.

All items found in the bracket are called the Geometric factor and they depend on the array, other terms are read from the terrameter.

Field Procedure

Basically, the field procedure in the electrical resistivity methods involves passing of artificial current through two electrodes into the subsurface and measuring the potential difference between the two currents electrodes through another two electrodes placed in line.

Terrameter MC 0hm MODEL 2115A mark-2, with all its accessories was used for the survey work. Both the horizontal electrical profiling and the Vertical Electric Sounding (VES) techniques were employed in this work. For the electrical mapping, the area was divided into nine (9) profiles at equal intervals of 50m. Each profile runs from west to east. Wenner array was used, with the electrodes spacing of 40m. As for the vertical electrical sounding, since regional survey was aimed at, the area was guided into twenty (20) sounding stations spaced at intervals of 100m.

Interpretation

The quantitative interpretation of the field data were carried out by the application of a computer iteration package (Zohdy, et al, 1989). This package (Zohdy) is capable of converting the values apparent resistivity as function of electrode spacing acquired as the field data to values of true resistivity as function of depth of individual layer for the actual condition in the ground to be interpreted.

However, the qualitative interpretation of the VES curves assumes that the earth is composed of horizontal layers with different resistivity referred to as geoelectric formation. Geological equivalent of these geoelectric sections are given in the figures 2 and 3 below.

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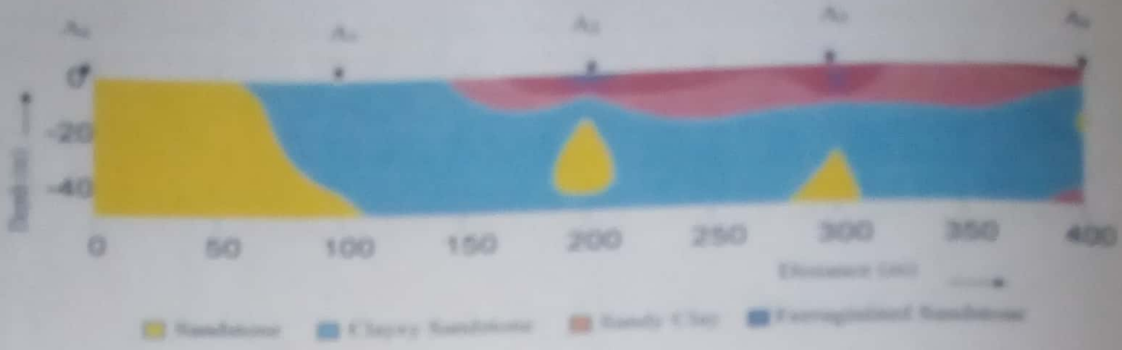

Fig. 2: Geologic Section of Profile A

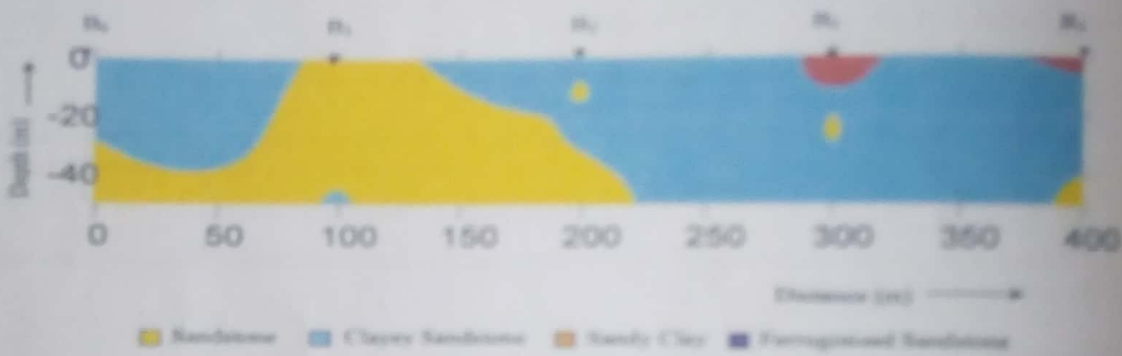

Fig. 3: Geologic Section of Profile B

III. Discussion

Based on the findings, it's found that the Nupe sandstone formation is composing of three and five horizons at different locations within the farm area, which are clearly seen on resistivity curves. Four types of formation were identified as sandstone, clayey sandstone, sandy clay soil and ferrugnized sandstone as shown on the figures.

The sandstone formation is considered as the primary aquifer while the clayey sandstone formation is the secondary and therefore can serve as a major enhancement. It can be seen that around the stations VES B_1, B_5, C_1 and C_2 fifth layer formation of lower resistivity than that of the sandstone exit. This formation is assumed to be still sandstone but with increase in salinity as a result of depth.

IV. Conclusion

The geophysical investigations delineated the geologic sequence within the vicinity of the El-Halal farm at Eye *Zheba* near Bida. The formation comprising of three and five horizons at different locations. The most potential areas for productive borehole drilling be carried out at points around stations; VES B_1, C_4, C_5 and D_3, with particular preference to VES C_5 and D_3.

Other potential areas are around VES B_0, B_2, B_3, C_0, C_4, D_1 and D_2. Boreholes should be drilled down to depths of about 70-75m.

V. Recommendations

The overburden should be penetrated by an 8" bit. A 6" PVC casing and screening be used to the bottom. The annulus space around the screen should be properly gravel packed with well sorted formation stabilizer, while the upper 6m of the space should properly be grouted with clear cement and water mixture to curtail any possibility of contaminations from the surface run off/effluents.

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