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PROBING INTO EARTH SURFACE TO DETERMINE THE SUITABILITY OF THE FORMATION FOR BUILDING AND ENGINEERING WORKS IN PAIKO TOWN AND ITS ENVIRONS

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ABSTRACT

This survey was carried out on an area covering about 629km^2 located within latitudes $6^0 37^1$E and $6^0 39^1$E and longitude $9^0 25^1$N and $9^0 27^1$N. A combination of lateral profiling with thirty profiles and vertical electrical sounding with ten (10) VES stations per zone. The lowest resistivity found on the resistivity contour map is about 600 Ωm, found at the North-eastern part of the map. The highest resistivity is about 7600 Ωm, found at the mid-central part of the contour map. Thicknesses are found to be between 9.00m to 35.00 m, 10.00 m to 33.00 m and 7.00 m to 22.00 m in different places within the three zones, that is A, B and C. Going by the result from the three zones, it is found that the area is generally good and suitable for buildings and other kinds of engineering work.

Keyword: Depth, Aquifer, Resistivity, Geoelectric and Basement

INTRODUCTION

Paiko town is the headquarters of Paikoro Local Government Area in Niger State of Nigeria. The Town is about 25km from Minna town, the capital of Niger State. It shares common boundary with Chanchaga Local Government Area at the Western part and with Suleja Local Government Area at the Eastern part of the state. It is located on the longitudes $9^0 25^1$ and $9^0 27^1$N and latitudes $6^0 37^1$E and $6^0 39^1$E. The area is about 629km^2. In the area many geological surveys have taken place in the past by companies such as Ruwastan in Niger State and some individual too numerous to mention. The kind of survey the area lack till this time, is the geophysical survey that encompasses all the attributes of survey, as it will be seen in this work.

The parameters to be investigated include aquifer thickness, depth to basement and distribution of weathered basement. Groundwater formation, occurrence and movements depend on lithologic petrography, geo-structural, geotectonic, geomorphologic and other factor (Ogilvy, 1967). Geophysical method of investigation has found useful applications in areas such as bedrock delineation, saline water mapping, lithological boundary differentiation and determination of structural trends among others (Emenike, 2001; Dangana, 2009; Mallam, 2006;). This Geophysical survey employed the resistivity method using both Wenner Array and Schlumberger Array spreads. The reason for employing resistivity method is because it is very important in Engineering Geology, where this techniques is used to measure the depth to bedrock in a prospective dam site and location of shallow mineral deposits and underground water (Telford *et al*, 1989).

The main purpose of this work was to determine the depth to the basement, the distribution of the weathered basement, and to locate the points that are good aquifer within the study area.

Physiography and Geology

Paiko area is purely within the basement complex of Northern Nigeria, which started from far North and extend to Lokoja area of the Mid-Central Northern Nigeria. The geology of the basement complex rocks has been discussed in detail in the works of the likes of McCurry (1975), Van-Breemen (1981), and Ajibade (1980).

The area is, therefore, underlain by four lithologies as is evident from the rocks in the area. The rock types in this region include: granites, gneisses, quartzites as well as laterites, while most of the granites seen here are older granites and this distinguish them from the younger granites found in Jos area, (Figure 1).

MATERIALS AND METHODS

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.

Resistivity measurements were made along some thirty profiles (Figure 2), covering an area of about 629km^2. Each profile runs North-South and are perpendicular to the express road running from Minna-Suleja, until all the field was covered.

As a result of the position of the site or town, which is surrounded or linked by many roads including feeder roads, it was convenient to divide the area into three zones namely; A, B and C.

This division into three zones enable us to carry out sounding, employing the Schlumberger spread. A total of thirty (30) VES stations were sounded, with ten (10) stations per zone. The theory behind these spreads are well discussed in detail in sources such as Telford, (1989), Parasnis (1986). In Wenner array method used for this investigation, the electrode 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

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

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

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

Simplifying, since $(L - X) >> 1$, we have

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

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

$$\rho_a = \frac{\pi L^2}{2L} \left\{\frac{\Delta V}{I}\right\} \text{ - - - - - - - - } 4$$

where L = half the separation of the current electrodes, lL = 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 $r_4 (L+X)-L$

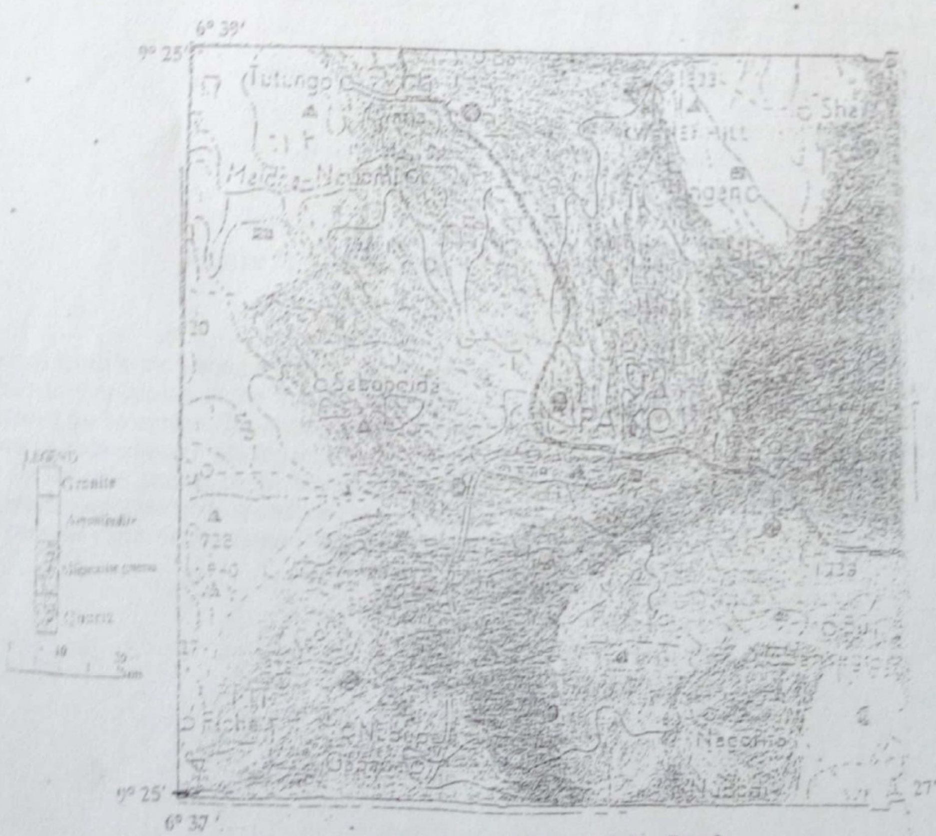


Figure 1: Geological Map of the Study

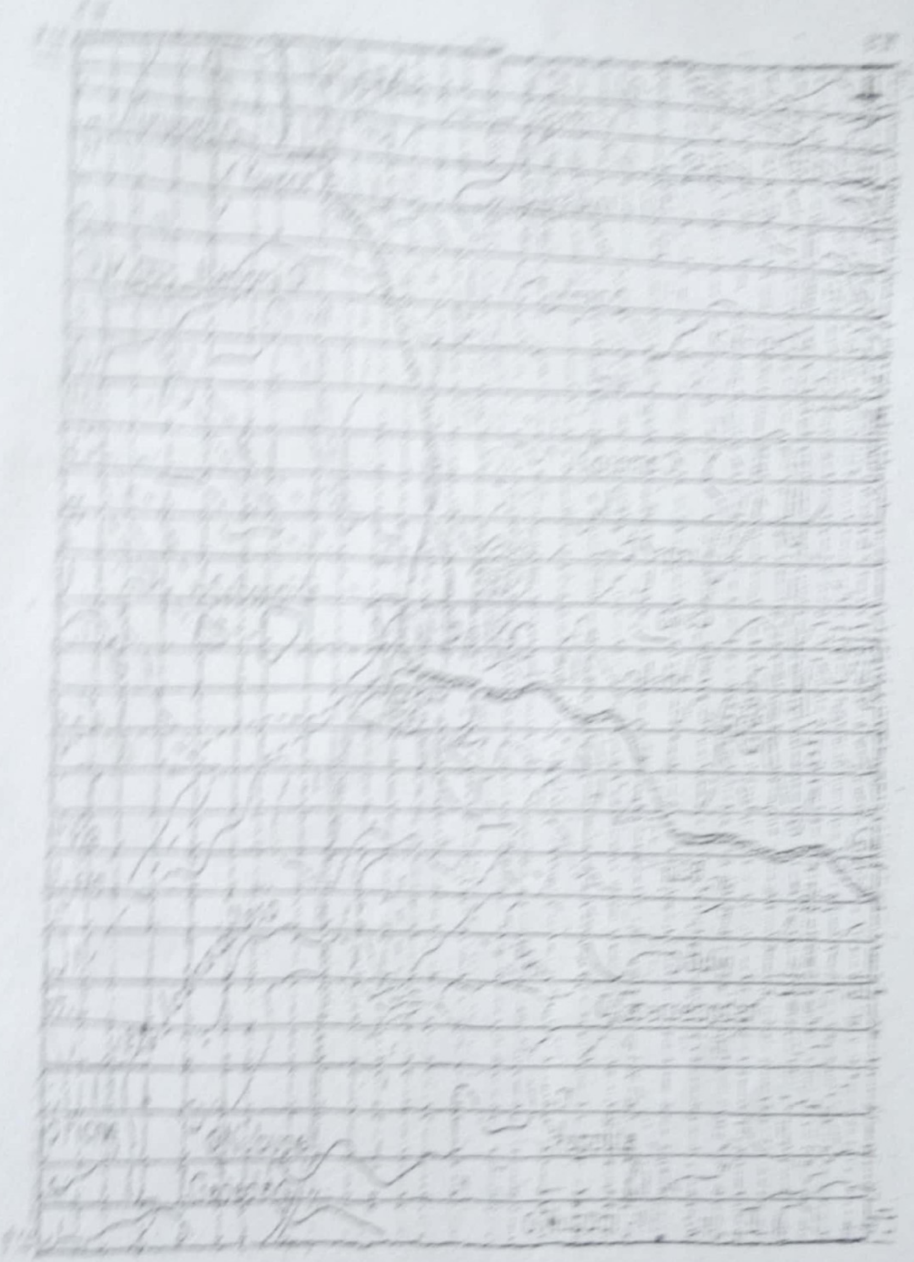
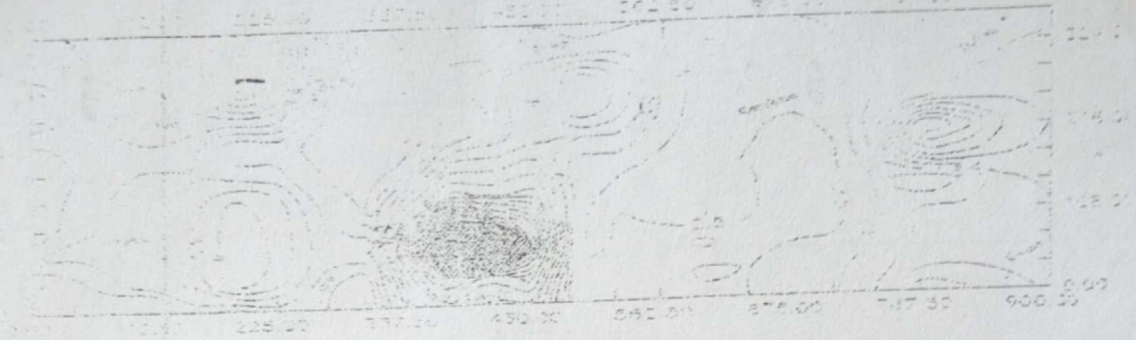


Figure 2: True resistivity (digitized) layer models for the study area

All items found in the bracket are called the Geometric factor and they depend on the array, other terms are read from the terrameter. The instrument used in this survey for data collection was terrameter SAS 300 DC, and for effective probing of the basement complex, maximum current electrode separation (AB) of 200 m, and potential electrode separation (MN) of 40 m were used. The grid stations were located by the use of wooden pegs marked with red paint, and to cover the all area effectively, intervals of 100 m were used between each station points. Figure 3 shows the resistivity contour maps of the study area from which the geologic sections were obtained.

Data Interpretation



Resistivity Map of zone A

Resistivity Map of zone B

Resistivity Map of zone C

Figure 3: Resistivity Contour Maps of the study Area, interval 100Ωm

During the quantitative interpretation of this survey work, an interactive computer package designed by (Zhody *et al*, 1989) was employed. This package was able to reveal the resistivity curves, from which the number of layers, thicknesses and resistivity values were clearly shown. Samples of a typical digitized data and interpreted curves are shown (Figures 4a and b).

The geoelectric sections along the zones were obtained using the interpreted model parameter (resistivity and thickness) for each VES stations. The VES stations were marked along the corresponding profiles and layer thickness beneath each sounding station and the resistivity were plotted. These derived geoelectric sections were subsequently used to obtain the geologic sections. It was possible to construct the equivalent subsurface geological sections from the contour maps of the zones.

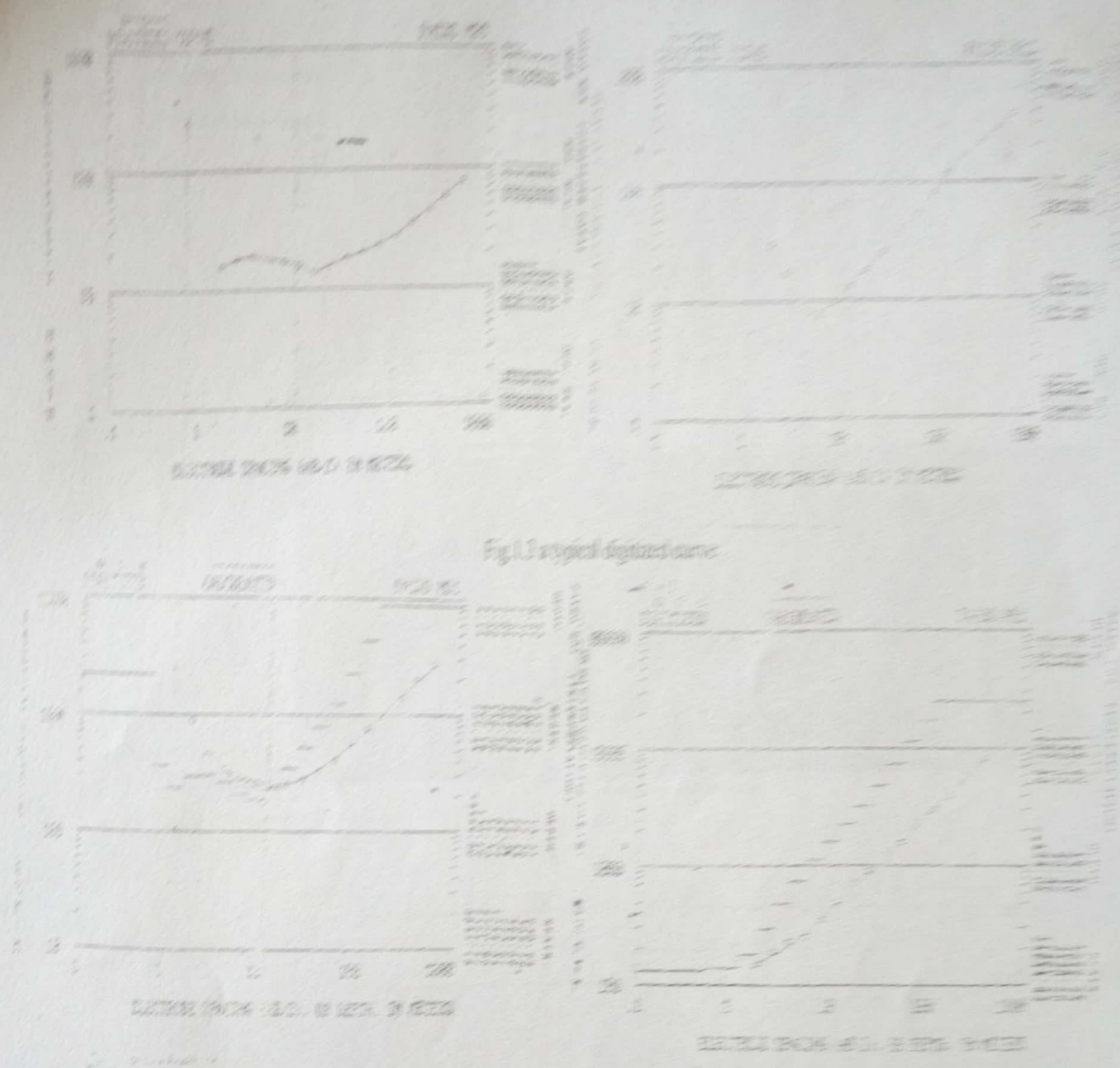


Figure 4: Digitized and Interpreted Curves

DISCUSSION

Going by the data interpretation of the geophysical survey, it can be said that: (1) Some areas are good and suitable for groundwater potentials, (i.e, VES 4 of zone A and VES 3 of zone C). (2) That the geological layers of the area are four. Lateritic, coarse sand, clay forms the first layer. Weathered basement, the second layer. Fractured basement form the third layer and fourth layer is the fresh basement. (3) thicknesses of the various lithologies were revealed and the average thicknesses of the weathered basement for zones were taken as; 9.00 m to 35.00 m , 10.00 m to 33.00 m and 7.00 m to 22.00 m for zones A, B and C respectively. (4) Various resistivity values ranging from the lowest 600 Ωm to the highest 7600 Ωm were taken across the zones.(5) The geoelectric sections arrived at were four, given more credence to point two above (Figure 5).

CONCLUSION AND RECOMMENDATION

From the results put together, it is clear that Electrical resistivity method is very suitable and efficient. From the results, we have that four lithological layers were present in the area and that all other constituents were brought to focus. It is recommended that, borehole drillings be carried out in the area (VES 4 of zone A and VES 3 of zone C) and the water be certified well for drinking and for domestic use through standard scientific analysis.

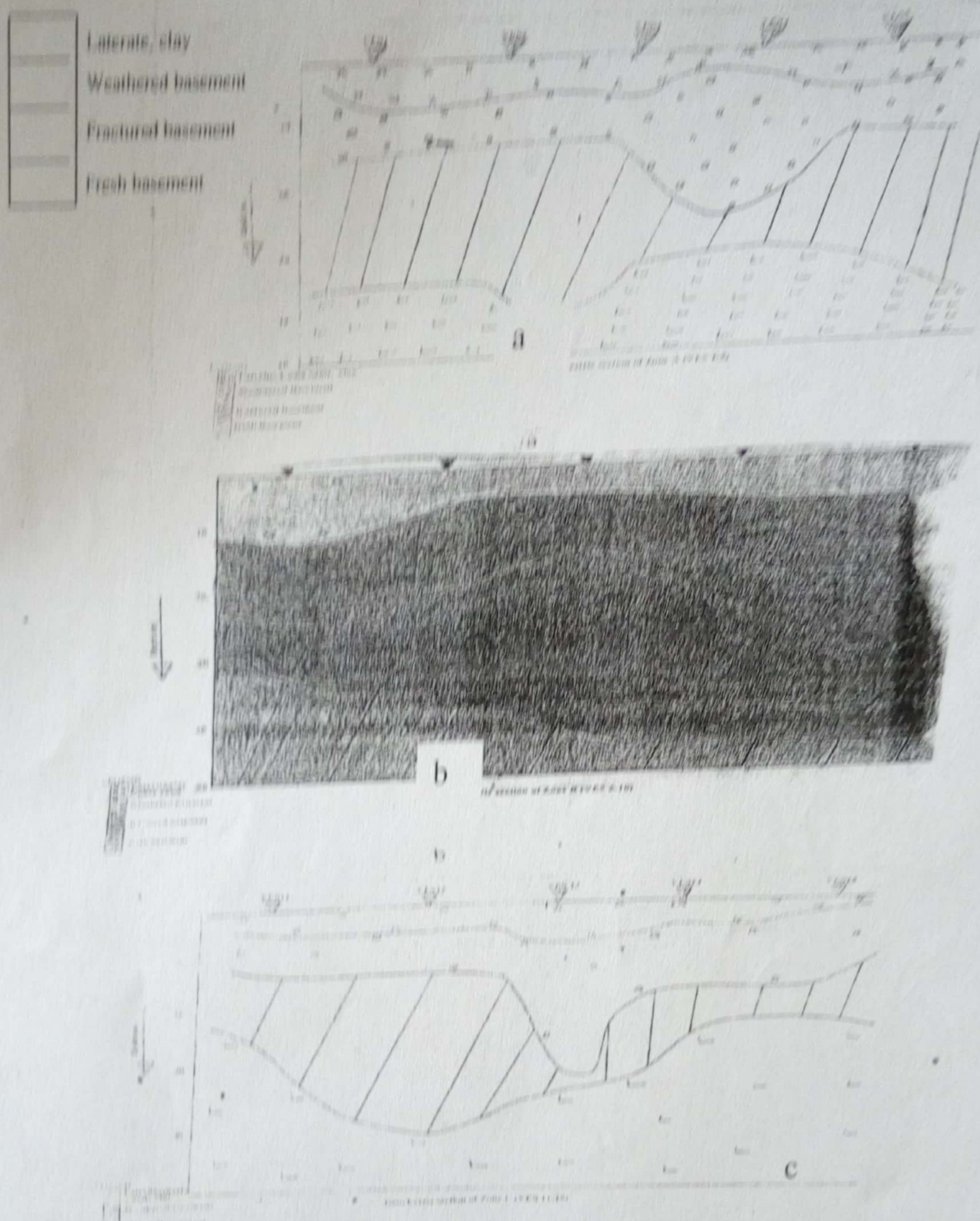


Figure 5: Geologic sections of the

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