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Determination of Thickness of Overburden in Basement Area Using Schlumberger Electrodes Array

S.O. Agha[1], C. Agha[2], P.A. Nwofe[1]

[1]*Department of Industrial Physics, Ebonyi State University, P.M.B 53, Abakaliki, Nigeria*

[2]*Department of Science Education, Ebonyi State University, P.M.B 53, Abakaliki, Nigeria*

Abstract : *The overburden thickness of Abuja (Lat. 7^0 12´N – 9^0 30´ N and Long. 5^0 24´E- 7^0 19´E) has been estimated. The geophysical method used was the electrical resistivity and the electrodes array was Schlumberger type. The equipment utilized were four electrodes, hammer, four reels of wires, crocodile clips, measuring tape, global positioning systems(GPS) and a terrameter. The survey was carried out in two locations and the average resistivity values of the first four geoelectrical layers were from the surface, 590 Ωm, 1800 Ωm, 1900 Ωm and 760 Ωm. These layers were interpreted as probably top soil, laterite, weathered basement rock and fairly weathered basement rock. The average thickness of the overburden was found to be 5.43m.*
Keywords – *Basement, Geo-electrical, Overburden, Resistivity, Schlumberger*

I. Introduction

In order to study the earth's subsurface, a lot of geological and geophysical techniques such as seismic, electrical, gravity, magnetic electromagnetic and radioactive measurements are involved. To choose any one of the techniques listed above, we however, consider the suitability of such technique to produce sufficient information needed in a given geological setting. In the applications of geophysical methods for engineering studies, electrical resistivity, magnetic and seismic refraction techniques are more commonly used [1-4].

This work is aimed at determining the thickness of overburden of Abuja, a basement complex in Northern Nigeria. Overburden refers to earth materials other than the hard rocks. It overlies the basement rocks. It can also be defined as loose, unconsolidated materials resting on bed rock. Information obtained from this work would be used to know how much materials (the overburden) can be scooped out from the surface in the study area before the basement can be reached and perhaps blasted. It would also be useful in the designing of any engineering structure such as building, foundation, roads and dams. The geophysical method chosen for this study is the electrical resistivity method. The method has been extensively used in various parts of Abuja for exploration. In 2004, Gilto Construction Company carried out a geophysical survey at Mabushi area of Abuja using vertical electrical sounding. The purpose was to investigate the groundwater potential of the area. The result showed that the average resistivity of the first six layers from the surface are 1182.23Ωm, 3129.01Ωm, 2014Ωm, 1108Ωm, 612Ωm, and 162Ωm with thicknesses of 1.3m, 2.3m, 14.0m, 2.0m, 10.0m and 15.0m respectively. These rocks were fractured and trended roughly in the North-South direction [5].

LOCATION AND GEOLOGY OF STUDY AREA

The study area Abuja, lies within latitude 7^0 12´N - 9^0. 30´N and longitude $5^0$24´E - 7^0 19´ E. It forms part of the basement complex of Northern Nigeria. Rocks in this area include gneisses, granite, migmatite, meta-sediments, and quartzite. Post-tectonic folding and fracturing are common features with these rocks being weathered in some places. The oldest rocks are the gneisses and the older meta-sediments. Owing to several processes of metamorphism, migmatisation and granitisation, occurring within a minimum of two tectonic cycles, the rocks within this zone were largely transformed to magmatites, granite, gneisses etc., while some relics of the initial granite remained unchanged. The basement complex was much later intruded by series of intermediate /plutonic rocks. These rocks were later fractured, trending in the North –South direction in conformity with the general strike of rocks of that period [6-7].

II. MATERIALS AND METHOD

The materials used for the survey include; current and potential electrode pairs and cables, pegs, knife, twine, measuring tape and a terrameter. The research was carried out using the Vertical electrical sounding (VES) method. The Vertical electrical sounding (VES) was done using the Schlumberger electrodes array as shown on Fig. 1.

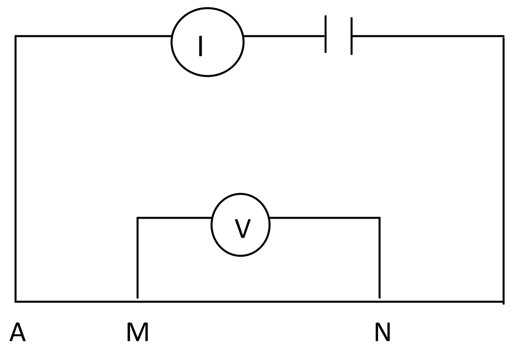

Fig 1: Schematic diagram of schlumberger electrodes array.

With the terrameter, electrical current (d. c) was passed into the ground. A and B are the current electrodes while M and N are the potential electrodes. The ratio of voltage (V) applied to current (I) flowing was multiplied by the geometrical factor, K to give apparent resistivity, expressed as

$$\rho_a = \frac{V}{I} \times K \qquad (1)$$

In equation 1, ρ_a is the apparent resistivity, where K, V, and I retains their meanings. Parameters measured and recorded were the half current electrode spread, AB/2,the half potential electrode spread, MN/2 and the electrical resistance, R = V/I. Parameters evaluated were the apparent resistivity, ρ_a and the geometrical factor ,K. VES curves were obtained by plotting ρ_a versus AB/2.

III. RESULTS AND DISCUSSION

The VES curves from two locations surveyed in the study area are shown in Figs. 2 and 3. The VES curves generated in the study area were matched with standard master curves and their auxiliaries. For location 1, the VES curve show basically seven layers with resistivities of 103 Ωm, 252 Ωm, 1637 Ωm, 302 Ωm, 327 Ωm, 362 Ωm, and 32.5Ωm. These layers were accordingly interpreted to be probably top soil, laterite, weathered basement rock, fairly weathered basement rock, basement rock, partially fractured basement rock, and fresh basement rock from the first to the seventh layer of the earth. In other words, top soil which is the first layer from the surface is underlain by a layer of laterite which overlies a series of basement layers.

The thicknesses of the layers were 1.4m, 5.9m, 18.6m, 2.0m, 2.2m and 5.1m for the first six layers from the earth's surface respectively. The thickness of the seventh layer could not be obtained. For location two seven lithologic units were delineated. The layer resistivities are from the surface 1085 Ωm, 3258 Ωm, 2104 Ωm, 1208 Ωm, 692 Ωm, 162 Ωm, and 282 Ωm. The thicknesses were 1.4m, 2.1m, 14.4m 2.2m, 10.2m, 5.3m and an undetermined thickness from the first to the seventh layer respectively. The lithologic interpretations are top soil for the first layer, laterite for the second layer, weathered basement rock for the third layer, fairly weathered basement rock for the fourth layer, weathered basement rock for the fifth layer, partially fractured basement rock for the sixth layer and fresh basement rock for the seventh layer. Similar findings have been reported in the literature [8-10].

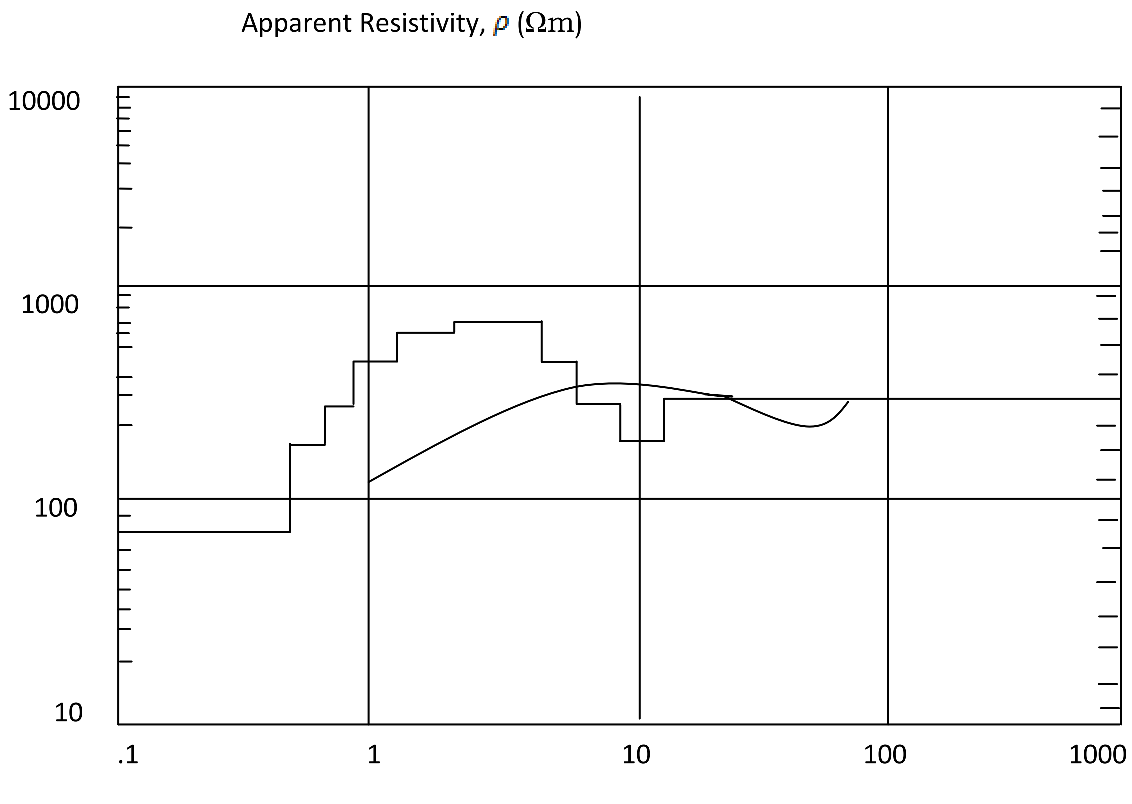

Fig 2: VES curve for location1.

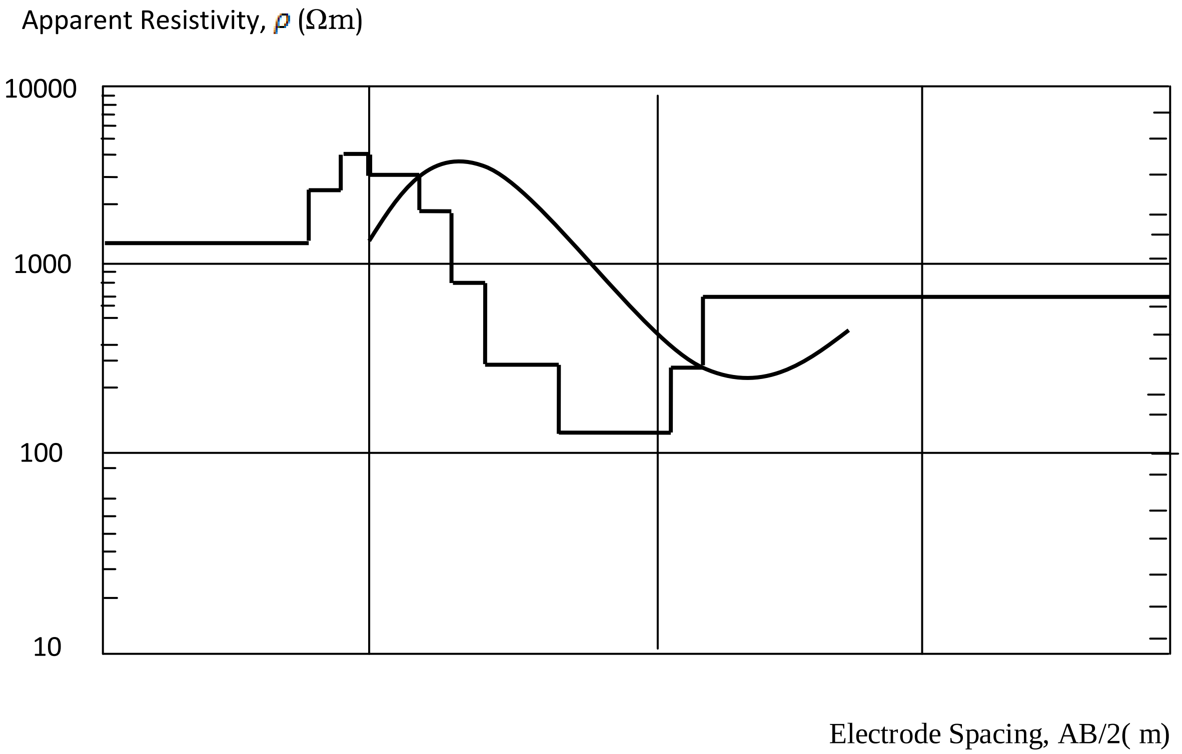

Fig. 3 VES curve for location 2.

IV. CONCLUSION

From the fore- going discussion, it is obvious that two lithologic units make up the overburden in each of the locations surveyed. These units include the top soil (having an average thickness of 7.3 m) and the lateritic soil (3.5m thick). The average thickness of the overburden for the study area is 5.43m. Generally, we conclude that the first two layers of Abuja consist of top soil and laetrile (as overburden) resting on a basement structure made up of predominantly weathered basement rock and fairly weathered basement rock. We recommend that another geophysical method such as the seismic refraction method be used to investigate the overburden thickness of Abuja so as to confirm our findings.

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