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GEOPHYSICAL INVESTIGATION OF WESTERN PART OF FEDERAL UNIVERSITY OF TECHNOLOGY, GIDAN KWANO CAMPUS, MINNA, NIGER STATE, USING ELECTRICAL METHOD.

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ABSTRACT

A geophysical survey of western part of Federal University of Technology, Gidan Kwano Campus, Minna, was carried out using the conventional Electrical Resistivity (VES) and Self Potential (SP) methods. The aim of this survey is to determine the ground water potentials of the area and to also locate those areas that could be useful for civil engineering purposes. The data obtained were interpreted using computer-based program called Zohdy. The resultant n-layered earth models were used to produce depth to basement map, iso-resistivity contour maps at different depths and the vertical sections through each profile. The interpreted earth-layered model suggests the existence of three geoelectric layers. The results of vertical sections were used to get the subsurface geologic sections. The results of the interpretations of the SP data agreed with the VES data deductions. The aquifer system of the study area is generally characterized by relatively low resistivity value between 200Ωm to about 800Ωm in the weathered basement and supported at some VES points by fractured basement and its thickness ranges from 3.8m to about 25m. The most promising region for groundwater development lies on North-central and North-eastern parts while the civil and the environmental works will be best located at the Southern part where the fresh basement is shallow.

INTRODUCTION

The growth of any community is a function of availability of basic infrastructural needs like water, roads, electricity and industries among others. Ground water is of significant importance to Northern Nigeria where the amount of rainfall is limited to very few months of the year with annual rainfall of 1000-1500mm [Eduvie, 1998], surface water sources are often inadequate or non existent [Baimba, 1978 and Perez and Barber, 1965]. There is need for scientific identification of parameters governing ground water resources, assessment and management, particularly if satisfactory living conditions of the inhabitants are to be catered for. The University is relocating three out of four schools or faculties from Bosso Campus to Gidan Kwano Campus. Consequently, there would be an increasing demand for portable water supply to complement the existing one on campus and the need to delineate the areas that would be suitable for civil-environmental development. Therefore, there is need to conduct hydrogeological and geophysical studies of the area to provide useful information on the possible sites for ground water development and to also locate the areas that will be better for erection of high rise buildings.

The Federal University of Technology (F.U.T), Gidan Kwano Campus, Minna, is located at Km 12 along Minna-Kateregi Bida road. The study area is located within the university campus and is about 1.8 km away from Minna-Kateregi Bida road, directly behind the student hostel, Figure 1. Federal University of Technology, Gidan Kwano Campus, Minna, is part of Minna NW sheet 42, on a scale of 1:250,000. It lies between latitude 9°28'N and 9°37'N and longitude 6°23'E to 6°29'E. The site covers an area of about 100,000 hectares with three defined sectors; North, Central and Southern sectors [Works Department, Federal University of Technology, Minna, 1983]. The study area is displaced from a minor road that passes besides girls' hostel block which is about 65m south of the road and covers 500m x 250m as shown in Figure 1.

The rock types found in the study area are believed to be part of the older granitic suite and are mostly exposed along the river channel where they appear in most cases weathered [Udensi, Ojo and Ajakaiye, 1986]. The major rock types are porphyritic, medium to fine grained granite [Adesoye, 1986 and Adeniyi, Udensi, and Okosun, 1988]. The results of the borehole log from the area show that the area has a good potential for ground water development [Jimoh, 1998].

The surface geoelectric (resistivity) method, particularly the VES method has been chosen for this work because it has proved to be an economic, quick and effective means of solving most ground water problems in different parts of the world [Brusse, 1963, Zohdy and. Jackson, 1969 and Frohlich, 1974]. The method is also used to estimate the thickness of the overburden as it is presented in this work [Parasnis, 1987].

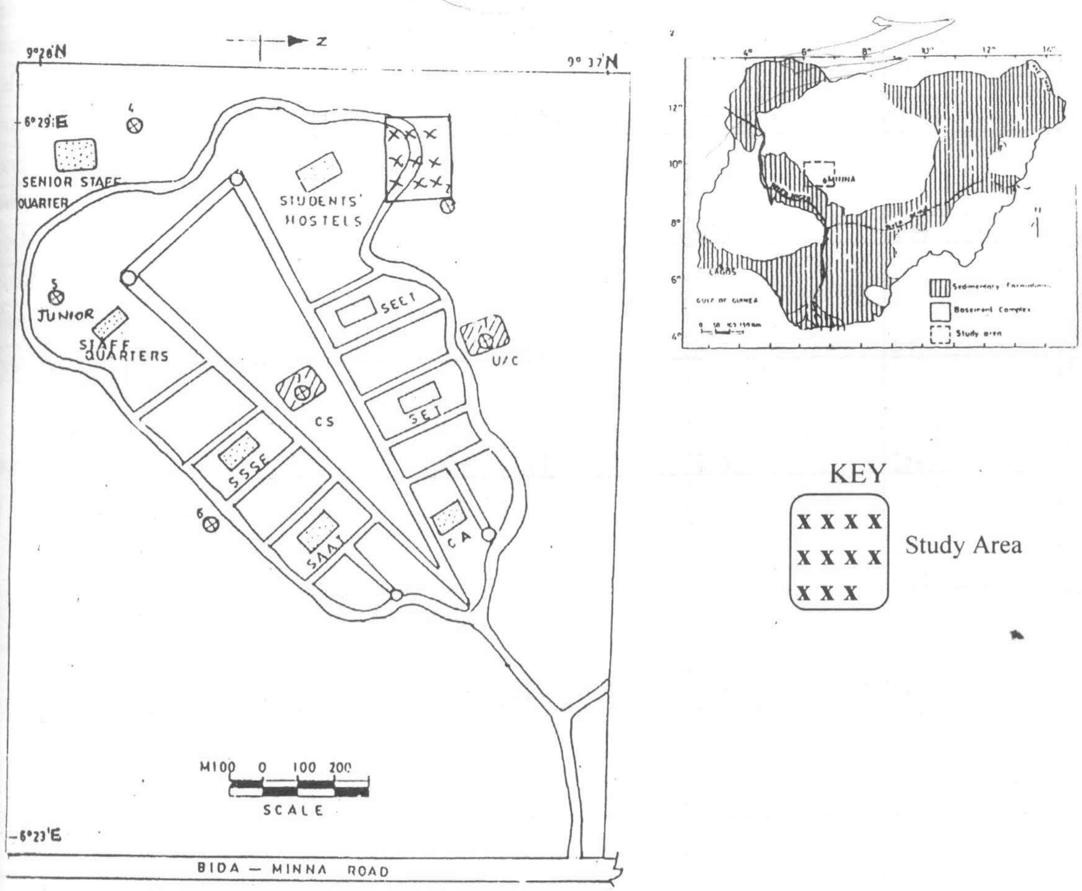


Figure 1: Map of Federal University of Technology, Gidan Kwano Campus, Minna. Showing the Location And Accessibility of the Study Area and The Geologic Map of Nigeria

DATA COLLECTION

The study area was gridded as shown in Figure 2. Sixty-six (66) VES points were covered. The Terrameter SAS 4000 was the instrument used and it is capable of operating in different modes, namely: Resistivity, Self-potential and Induced Polarization. The Schlumberger array method was used for the VES survey while the Werner array was used for SP survey.

DATA ANALYSIS

The interpretation was done using an iterative computer program, the Zohdy software. This program performs automatic interpretation of the Schlumberger sounding curves. This curve gives the equivalent n-layer model from the apparent resistivity of each sounding. Surfer8, a graphic computer package was used to produce the contour maps of data deduced from the Zoddy interpretation and also the SP data.

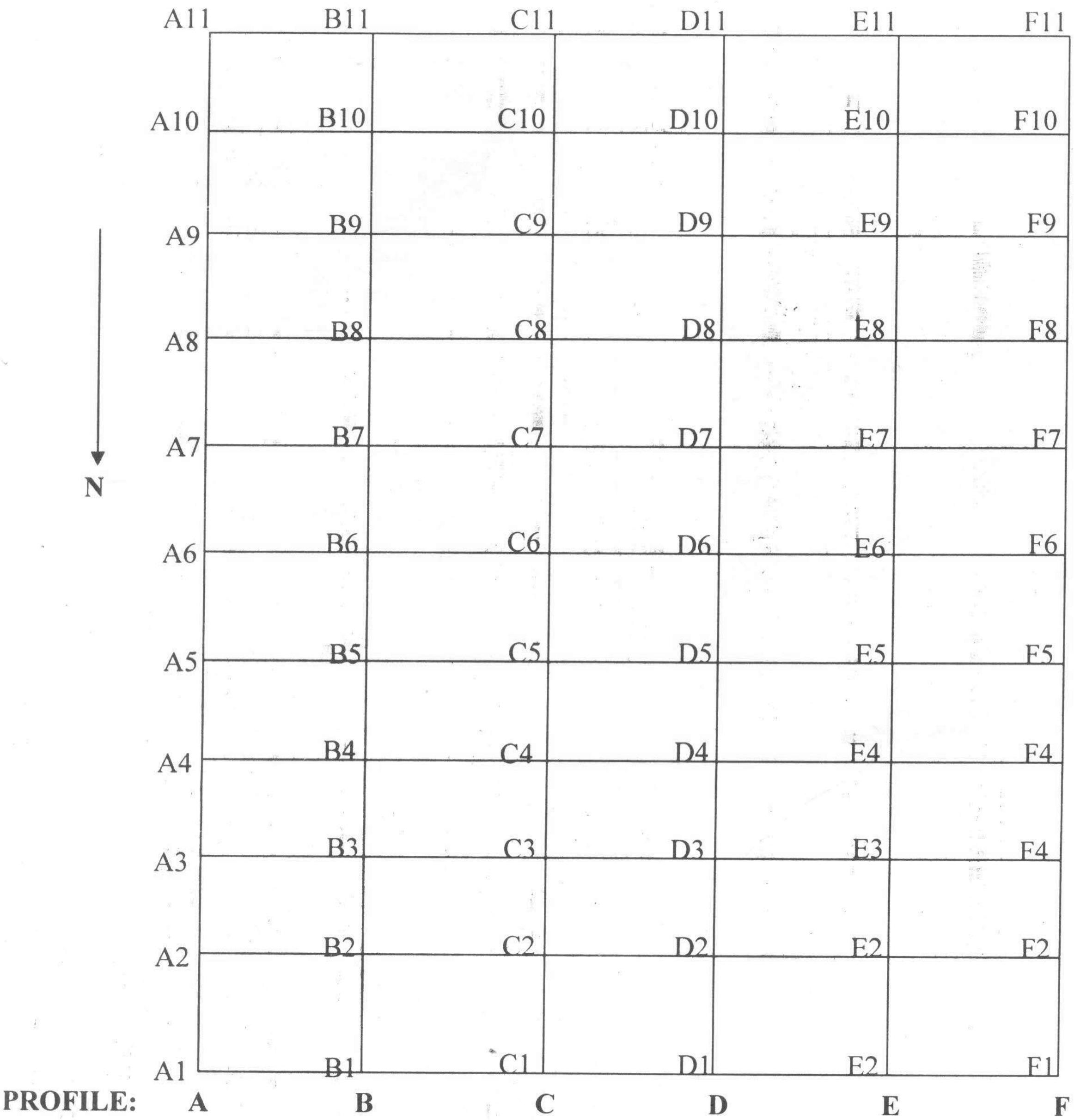


Figure 2: The survey outlay. The letters indicate the profiles while the numbers indicate th... ...ding points.

DATA INTERPRETATION

The interpreted Zohdy model was used to construct the following maps, which enhanced a very detailed interpretation of the field data obtained:

(i) Contour Map of Geo-electric Vertical Section through Profile
(ii) The Iso-resistivity maps at different depth and
(iii) Depth to Basement or Overburden Contour Map

INTERPRETATION OF VERTICAL SECTIONS THROUGH PROFILE

For easy and accurate interpretation of the results of the VES, electrical vertical section of each profile was derived from the Zohdy curves and contoured. The geologic section of each of the profiles was derived from the geoelectric vertical-sections using the available resistivity values of rock types in basement area (Table

Table 1: Resistivity values of Rock types in basement Area [Ajayi and Hassan, 1990]

Rock Type	Resistivity (ohm-m)
Fadama loam	30 – 90
Sandy	100 – 200
Sand and Gravel	100 – 180
Weathered Laterite	150 – 900
Fresh Laterite	900 – 3500
Weathered Basement	20 – 200
Fractured Basement	500 – 1000
Fresh Basement	>1000

The subsurface vertical sections through profile A - F are shown in figure 3 to 8 respectively. These maps were contoured at an interval of 300Ωm.

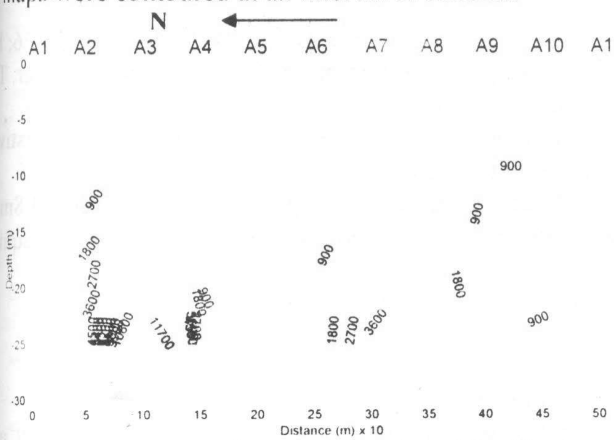


Figure3: Vertical section (Geoelectric) of Profile A (Contour Interval is 300Ωm)

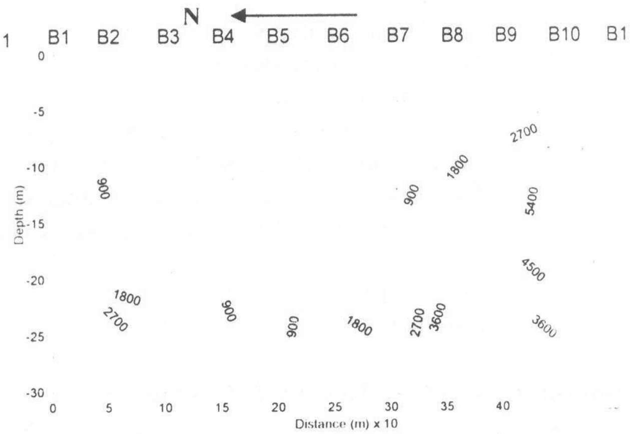


Figure4: Vertical section (Geoelectric) of Profile

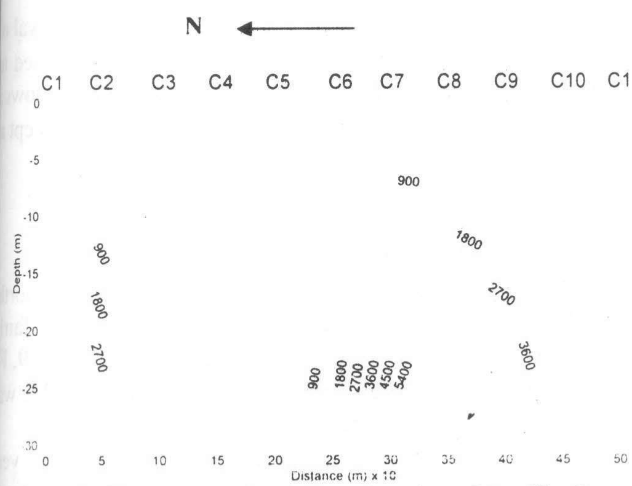


Figure5: Vertical section (Geoelectric) of Profile C (Contour Interval is 300Ωm)

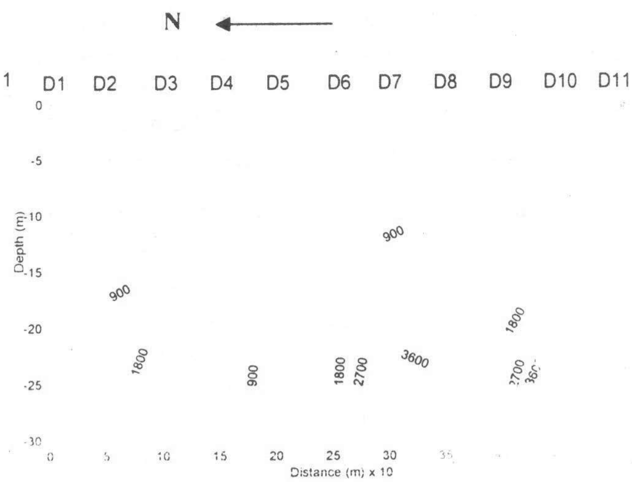


Figure6: Vertical section (Geoelectric) of Profile D

N

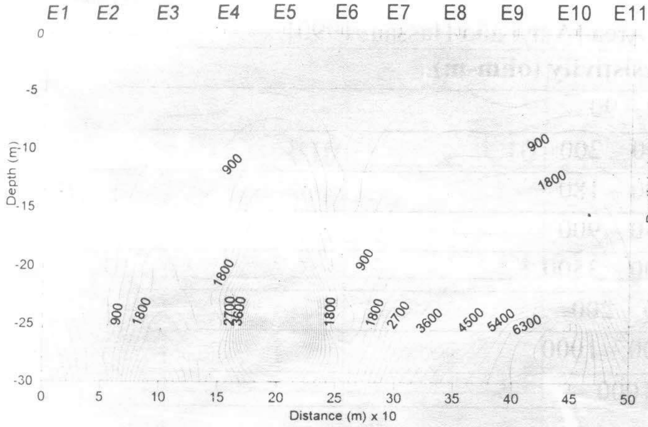


Figure7: Vertical section (Geoelectric) of Profile E (Contour Interval is 300Ωm)

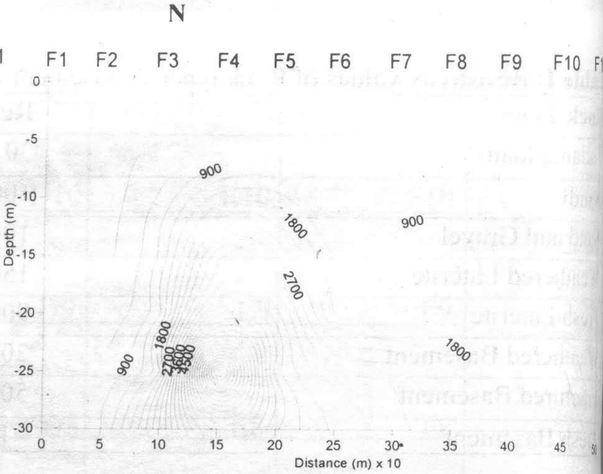


Figure8: Vertical section (Geoelectric) of Profile F

Figures 3 to 8 indicate that C3, to C5 and C10; A4 to A6, A9 and A11; B2, B5 and B7; D4; E2 and E6; F F2 and possibly F9 to F11 are depressions (valley) that may likely be good potential for underground water. Th following are the lithology layers and their thickness as obtained in this work:

(i) First layer consists of dry Lateritic topsoil, fadama loam, sandy-clay, and gravel and has resistiv values below 300Ωm with thickness between 0.39m to about 20.0m

(ii) The second layer consists of weathered and fractured basement with thickness between 3.8m t about 25m, its resistivity values ranges from 300Ωm and about 900Ωm. This constitutes the aquif system of this area.

(iii) The third layer is the fresh crystalline basement, which constitutes the bedrock of the area infinite thickness.

Interpretation of Iso-Resistivity Contour Map At Various Depths

Iso-resistivity maps show the conductivity pattern with depth through slicing of the entire study are horizontally or through a cross-section. The cross-sectional maps were used to corroborate the results of th vertical sections. These maps include the resistivity map of the topmost layer and iso-resistivity maps a depth of 5m, 10m, 15m, 20m, 25m and at 30m. The deductions made from them are discussed below.

The Iso-Resistivity Map At The Surface

Figure 9 shows the iso-resistivity contour map for topsoil. The map was drawn at contour interval o 100Ωm. The map shows a spatial variation of the resistivity of the topmost layer, which could be used t compare with the surface features like stream and exposed outcrops. The entire surface of the study area shows kind of low resistivity values ranges between 100Ωm and 200Ωm, which covers most part of the area except a southeastern part, which show high resistivity value.

The Iso-Resistivity Contour Map At Various Depth And Basement Contour Map

The Iso-resistivity contour map at 10m depth, contoured at 200Ωm interval as shown in figure resistivity value of 200Ωm to 400Ωm could be observed at central, north eastern, south-western and north-western part, this zone may likely show saturated or nearly saturated (water) horizons. The fractured or fairly weathered basement could be found prominently at south-western part of the map (i.e. VES D8, D9, E8, E9, F8 and F9) with resistivity value ranges between 400Ωm and 600Ωm. Very high resistivity value of 1000Ωm was found prominent at south-eastern part and VES B1. They are fresh basement rock.

The Iso-resistivity contour map at 15m depth, figure 11, is contoured at 500Ωm interval. This is very similar to map obtained at 10m depth only that those area that are said to be fractured jumped up to resistivity value of 1000Ωm and above and this corresponds to the shaded part of figure 14.

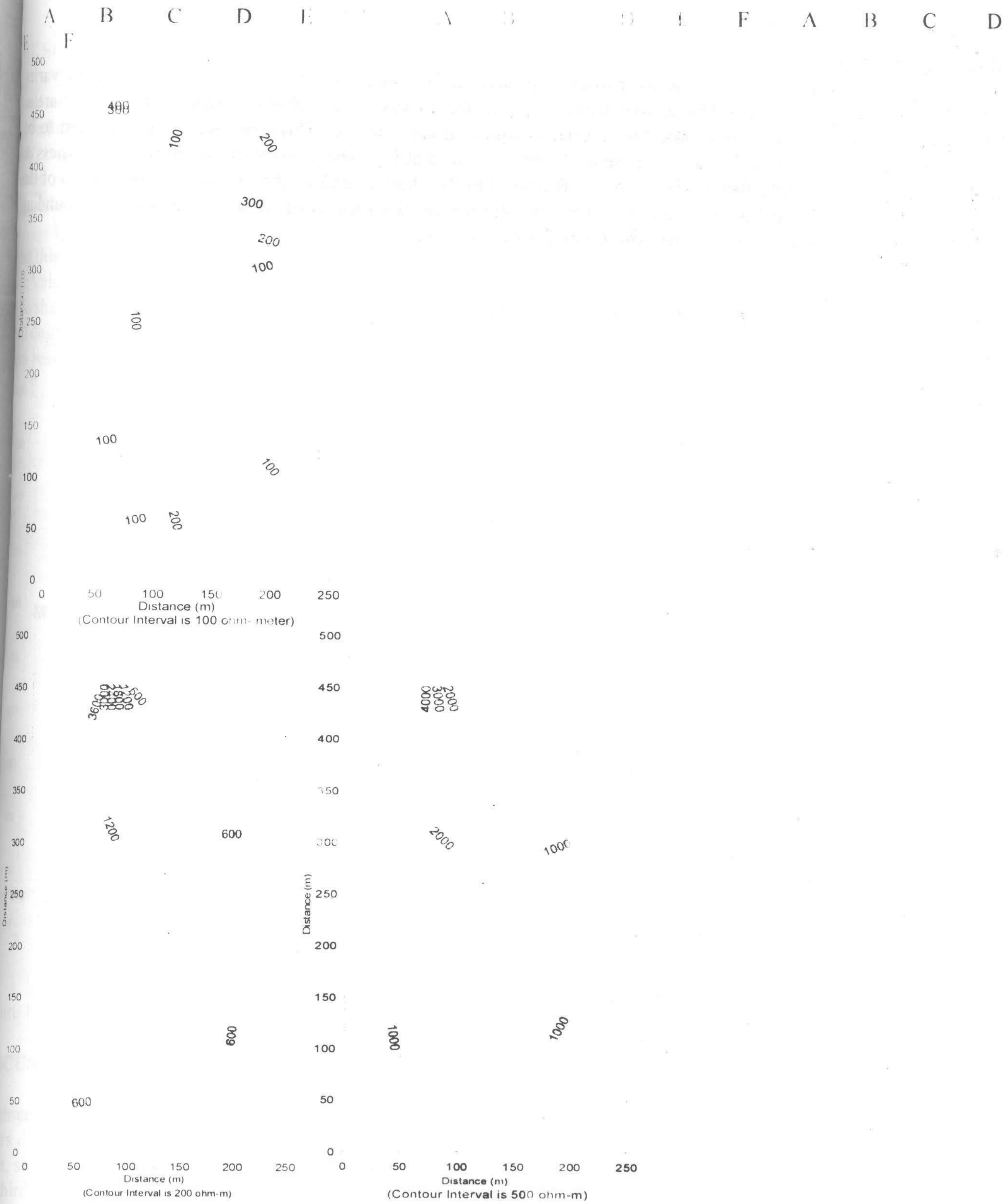


Figure 9, 10 and 11,: Iso-Resistivity Contour Map of topsoil. 10m Depth and 15m Depth respectively

The iso-resistivity contour map at 20m-depth, figure 12, is contoured at 500Ωm interval. Areas delineated with less than 1000Ωm are likely to contain weathered and fractured basement rock. The Iso-resistivity contour map at 30m-depth, figure 13, is contoured at 1000Ωm interval. It shows better, area of shallow overburden and thick overburden. The area characterized with resistivity value within 1000Ωm corresponds to the shaded area of figure 14.

Map of Depth To Basement

Figure 14 is the depth to basement map contoured at 2m intervals. It shows that the basement varies between 4.0m and about 36.0m. The southeastern region of the survey area is characterized as shallowest areas. This could be attributed to heavy outcrop of granite found at the surface. Thus the overburden is said to be shallowest at those area. The deepest basement (36.0m) is found at C3. The areas with overburden thickness or depth to basement between 16m to about 36m correspond to the shaded area of the figure 14. The results of the iso-resistivity and depth to basement maps corroborate the results from the vertical section maps. The sounding point C3 shown in figure 5 is well corroborated by figure 14.

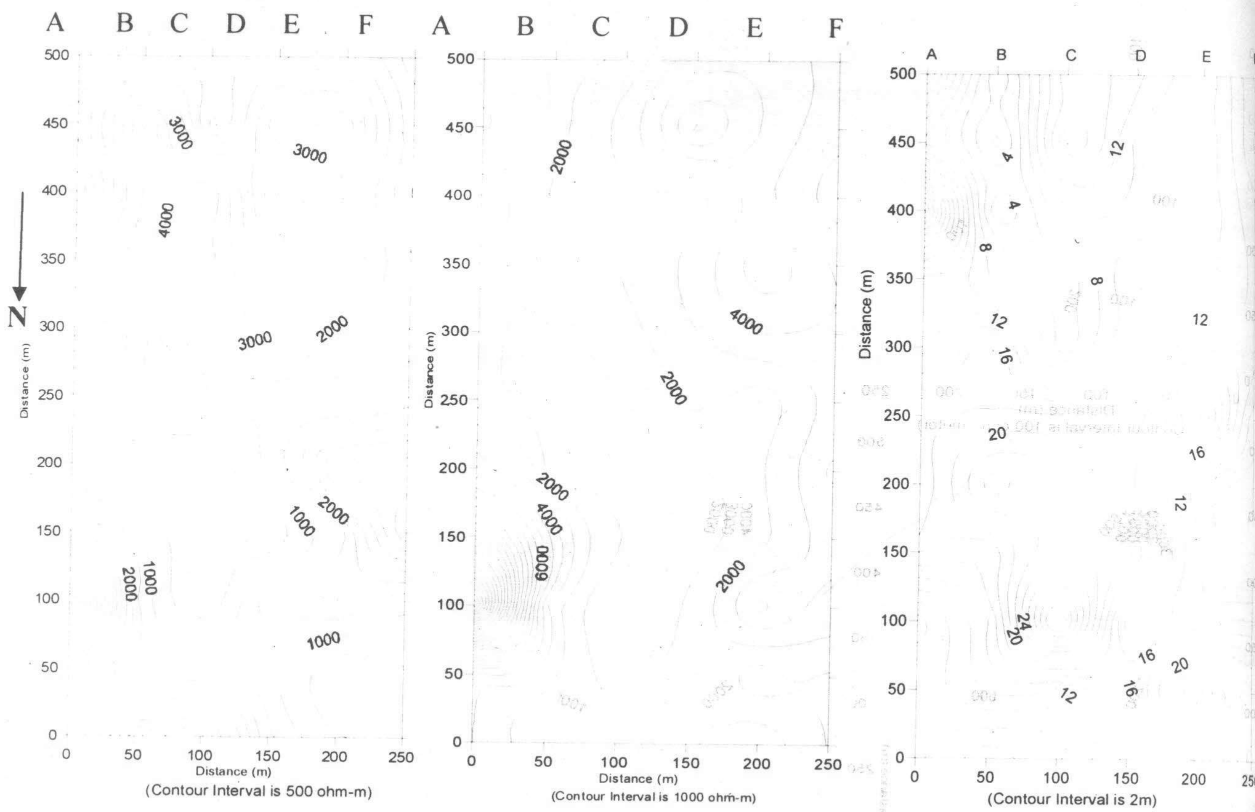
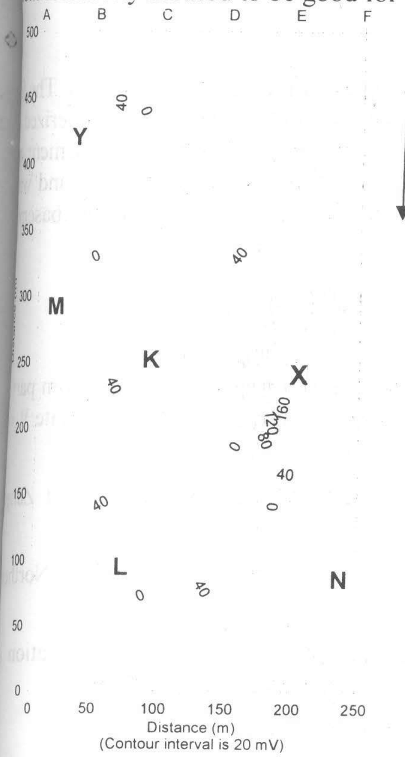


Figure 12, 13 and 14: Iso-resistivity contour Map at 20m Depth, 30m Depth and Depth to Basement contour Map Respectively

HE SELF-POTENTIAL (SP) CONTOUR MAP

The Self-Potential (SP) contour map is shown in figure (15). The map is contoured at an interval of 0mV. Since the interpretation of SP anomaly is only qualitative, visual inspection of this figure shows that the igure has about four low closures. These closures, marked K, L, M and N have potential amplitude between mV to about -6mV and are good areas for ground water development, since the earth conductivity increases ith more dissolved salt (impurities). These areas agree with those areas delineated through resistivity method igure 14). Hence, this method corroborates the results obtained from electrical sounding.

High negative potentials characterize the presence of mineral (ore) deposits, which were not observed om this map. Some high positive potential closures, marked X and Y, are found at the western part of the area ith values up to 180mV and southeastern part with values up to 60mV. These areas were delineated from VES be shallow basement region. This corresponds to the eastern part and the western part and it could be good for vil engineering works. These areas with potentials between -60mV to about 40mV are areas mostly designated om resistivity method to be good for groundwater development.



igure 15 Self Potential Contour Map

ISCUSSION

From the VES data, the thickness and the resistivity values of different layers were determined. There re three geologic units found beneath VES station, which revealed various lithological compositions of various ayers delineated. The geologic sections formed revealed that the first layer consists of lateritic topsoil, fadama oam, sand-clay and gravel. The second layer suggests the presence of weathered and fractured basement, while he third layer constitutes the fresh basement of the area.

The map of depth to basement figure 14 shows that, areas with outcrop of granite are the areas that have their basement uplifted and therefore have shallow overburden. This is prominent at southern part and northeastern part. The areas with basement depth between 18.0m and 32.0m are the areas characterized by lowland and fadama. This area corresponds to the shaded region of figure 14 and is therefore characterized with very thick overburden.

There are about three main factors that determine the areas suitable for ground water exploitation, these are:

(i) the conductivity of the subsurface, [Aboh, 1996].
(ii) The presence of suitable aquifer and
(iii) The thickness of the aquifer

From the above factors, zones or areas that will be considered to be suitable for ground wa exploitations are the weathered basement, which is the major component for aquifer system. Aquifer system the basement areas was classified to consist of weathered and fractured basement [Ajayi, and Hassan, 19 Dogara, 1995]. Thus, where the fractured zone is saturated, relatively high groundwater yield can be obtain from borehole penetrating such a sequence. Weathered and fractured basement (i.e. the second layer of t survey area) satisfies these three conditions. Similarly, areas of deep basement depressions of shallow basem probably serve as recharge points for underground water [Ajayi, and Hassan, 1990]. Figures 3-8 (vert sections) show that, those areas with depression features (valley) are those areas delineated as good potenti underground water resources. This is corroborates with both the iso-resistivity contour maps at var including the depth to basement contour map, and SP results. Similarly, those areas with elevated baseme could be better used for civil engineering works.

CONCLUSION

The results of the investigation show that the study area is underlain by three geological layers. The fi layer consists of lateritic topsoil, fadama loam, sandy-clay and gravel. The second layer is characterized weathered and fractured basement, while the third layer is the fresh basement rock. Weathered basement a fractured basement constitute the aquifer system found on the study area. The areas identified for ground wa exploitation are in the north-central and northeastern parts. The southern part of the study area where the basem is shallow, is however good for civil engineering works.

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