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Analysis of Resistivity Data in Exploration for Water (A Case Study of Ezzamgbo)

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Abstract: Electrical resistivity survey was carried out at three different locations in Ezzamgbo (longitude 8.1° - 8.2°E and latitude 6.2° -6.3°N). The ABEM terrameter Signal Averaging System (SAS 300C) was used with the schlumberger electrodes configuration. Only computer modeling was used for interpretation of the data. The depth sounding indicates the presence of six geoelectric layers in each of the locations surveyed. From the results the average resistivities and thicknesses of the study area are 951Ωm and 1.5m for the first layer; 507 Ωm and 7.4m for the second layer; 227Ωm and 13.5m for the third layer; 2014Ωm and 11.6m for the fourth layer; 573Ωm and 9.9m for the fifth layer respectively. The sixth layer has an average resistivity of 1333Ωm but its thickness could not be determined. The lithologic interpretations of the layers are probably lateritic top soil, clay concretions, wet shale, partially indurated layer, fractured and damp shale and dry mudstone from the first to the sixth layer respectively. The result indicates that underground water could be located in the fifth layer of Ezzamgbo.

Key words: Electrode · Exploration · Resistivity · Shale and geoelectrical

INTRODUCTION

The purpose of electrical survey is to determine the subsurface resistivity distribution by making measurements on the ground surface. The measured resistivity is the apparent resistivity of the ground. The resistivity of a rock is related to various geological parameters such as the mineral and fluid content, porosity and degree of water saturation in the voids [1]. Electrical resistivity surveys have been used for many decades in hydrogeological, mining and geotechnical investigations. The objective of this study is to use direct current resistivity survey to explore for water in Ezzamgbo. Ezzmgbo is located within longitudes 8.1° - 8.2°E and latitudes 6.2° -6.3'N and has an area of about 20km^2. There are no known previous geophysical surveys carried out at Ezzamgbo. However many geophysical works have been done in neighboring towns like Abakaliki, Nkwagu and Afikpo. Agha and Arua [2] carried out geophysical surveys at Abakaliki, Nigeria with the aim of investigating the sequence of deposition of sedimentary strata in the area. The D.C resistivity method and Seismic refraction method were jointly used. ABEM terameter (SAS 300C) was the major instrument used in the resistivity survey, while a signal enhancement seismograph with model number MOD. S79 was the major instrument used for the refraction survey. Five geoelectrical layers were delineated by the current in the resistivity survey, while only three geoseismic layer were delineated by the compressional waves used in the seismic refraction survey. The three geoseismic layers had compressional wave velocities of 725m/s, 1994m/s and 3168m/s for the first, second and third layers respectively. These were interpreted to be probably made up of Lateritic overburden, clay and carboniferous siltstone for the first three layers respectively. The resistivity result however show that the first five layers of the study area from the surface with resistivities 872.94cm, 268.34cm, 1169.84cm, 1766.17cmand 80.67cm consist of Laterictic overburden, Ferruginised clay concretions, siltstone bed, well compacted but fissile shale bed and well consolidated and mineralized layer from top to button for the first five layers from the earth's surface respectively [3-5].

MATERIALS AND METHODS

Intruments: The instrument used in this study is a geosensor terameter with its accessories including current and potential electrodes and cables, measurement tape, pegs and twine.

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Method: The method utilized is the electrical resistivity method with Schlumbeger electrodes array. Vertical electrical sounding (VES) was done. Three locations in the study area (Ezzamgbo) were surveyed. The locations include Amofia Ngbo, Ukwagba Ngbo and St. Michael's college. The procedures followed in the data collection include, marking out the center of the survey line in each location and hammering pegs accordingly up to the maximum current electrode spacing AB/2. The traverse orientation was determined using a compass. Marked twines were laid out on either sides of the peg up to the maximum value of AB/2. The potential and current electrodes were driven into the ground to about three quarters of their original length for effective ground contacts at chosen points. Connection of current and potential cables to the electrodes with crocodile clips and pin plug heads of the cables to the terameter (SAS 300C) was done. At any selected current range, the potential across the ground was measured by the voltage measuring mode of the terameter. The potential drops were measured automatically and the readings averaged continuously. These were recorded along with corresponding current electrode separations, AB. The current used in the survey was provided by a pack of dry batteries. The current was introduced into the ground by a pair of steel electrodes. The ratio of the potential drop, V to the current flowing, I gives the electrical resistance, R of the earth. The apparent resistivity, ρ_a of the earth was evaluated from the formula:

$$\rho_a = RxK.$$

where K is the geometrical factor. The apparent resistivity was then plotted against half the current electrode spacing, AB/2 using computer modeling.

RESULTS AND DISCUSSION

Results: The VES curves of the resistivity data obtained from the study area in the three locations chosen are shown in Figs. 1-3. Computer modeling was used to generate the curves (Graphs of apparent resistivity, ρ against half current electrode separation, AB/2).

Discussion: From Figs. 1-3, it is observed that the current sampled 6 geoelectric sections in each of the locations. For location 1, Amofia Ngbo, the true resistivities from the surface are: 907Ωm, 527Ωm, 282Ωm, 1699Ωm, 381Ωm and 1231Ωm for the first six layers respectively. The thicknesses were 1.77m, 8.69m, 11.5m, 10.5m, 9.33m and an

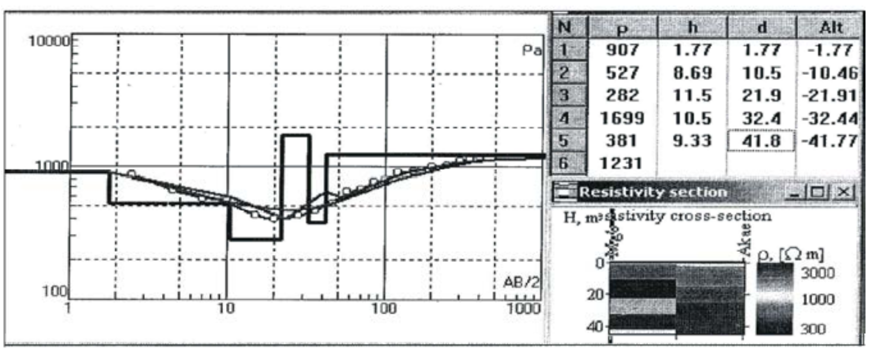


Fig. 1: VES curve of data from Amofia Ngbo

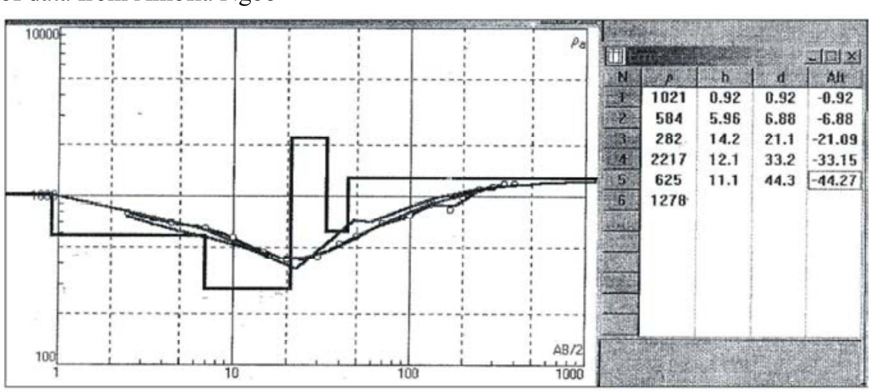
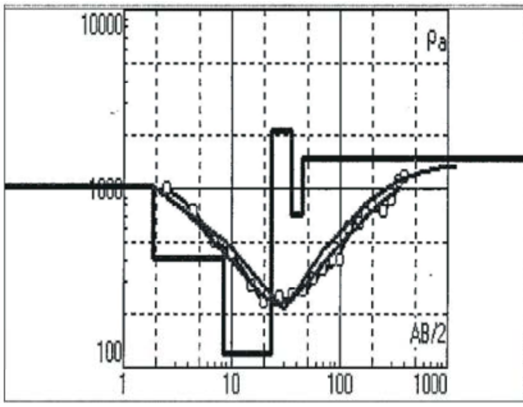


Fig. 2: VES curve of data from Ukwagba Ngbo



N	ρ	h	d	Alt
1	1025	1.88	1.88	-1.88
2	409	6.48	8.36	-8.36
3	118	14.8	23.1	-23.15
4	2126	12.3	35.4	-35.4
5	713	9.38	44.8	-44.78
6	1491			

Fig. 3: VES curve of data from St. Michael's college

undetermined thickness respectively. The sections were therefore interpreted to be: lateritic overburden, ferruginised clay, fissile shale, partially indurated hard stone layer, probably fractured shale layer and compact mineralized mudstones. At location 2, Ukwagba Ngbo, the current sampled 6 geoelectric sections with true resistivity from the surface as: 1021Ωm, 584Ωm, 282Ωm, 2217Ωm 625Ωm and 1278Ωm and thickness as: 0.92m, 5.96m, 14.2m, 12.1m, 11.1m and an undetermined value for the first six layers accordingly. The sections were therefore interpreted as: lateritic overburden, ferruginised clay, well consolidated fissile shale bed, Partially indurated limestone, Fairly fractured indurated shale layer and compact mineralized mudstones. At location 3, the current also sampled six geoelectric sections with true resistivities from the surface as: 1025Ωm, 409Ωm and 118Ωm, 2126Ωm, 713Ωm and 1491Ωm and thicknesses as: 1.88m, 6.48m, 14.8m, 12.3m 9.38m and an undetermined value for the first six layers respectively. The layers were interpreted as lateritic overburden, highly ferruginised clay concretions, well consolidated but fissile shale bed, partially indurated shale layer, partially fractured and damped shale layer and compact mineralized mudstone.

CONCLUSION

From the fore-going, the following conclusions are made:

- The three locations (Amofia Nbgo, Ukwagba Ngbo and St. Michaels college) possess similar electrical properties since the current delineated six layers in each of the locations.
- The top layer at each of the three locations is composed of lateritic overburden which has relatively high resistivity and low thickness values.
- The second layers in the three locations are composed of ferruginized clay which has some percentage of water content but the water here is seasonal and would be absent in dry seasons.
- The third layers are each made up of fissile shale.
- The fourth layer is a partially- indurated layer. Its exact lithology is not very obvious.
- The fifth layer in all three locations is fractured shale layer and it is probably damp.
- The sixth layer in each location consists of mineralized mudstone. This layer is probably dry.
- To drill a successful bore hole in this area, it must be between the fourth and the sixth layers to ensure good recharge. The fractured shale content of the fifth layer indicates good groundwater sources due to the cracks available in it. Therefore this zone has greater opportunity of yielding water to boreholes and shallow hand dug-wells that could be immense use to the people of Ezzamgbo.

Recommendation: It is recommended that studies into the hydro- physical and hydraulic properties of the aquifer systems in the study area be made to map out regions of ground water potentials for drilling of productive boreholes and for the installation of hand pumps. More closely spaced soundings should be made for wider ranges of result for comparison purpose. The VES electrode spacing should be increased so as to probe a greater depth for more structural information. Other geophysical techniques such as the seismic refraction and reflection methods should be employed since they can provide complimentary information about the research area.

REFERENCES

1. Lowrie, W., 1997. Fundamentals of Geophysics. Cambridge University Press, Cambridge, U.K.
2. Agha, S.O. and A.I. Arua, 2014. Integrated Geophysical Investigation of Sequence of Deposition of Sedimentary Strata in Abakaliki, Nigeria, European Journal of Physical and Environmental Sciences, 2(1): 1-5.
3. Agha S.O. and P.N. Nnabo, 2013. Lithologic deduction from resistivity studies at Nkwegu, Nigeria. 25, 183-186. Journal of the Nigerian Association of Mathematical Physics.
4. Kearey, P. and M. Books, 1991. An Introduction to Geophysical Exploration (2nd edition). Blackwell Scientific Publications. Oxford, pp: 198-217.
5. Telford, W.M., L.P. Geldart and D.A. Sheriff, 1976. Applied Geophysics Cambridge University press, New York, pp: 218-399.