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Full Length Research Paper

Investigation of groundwater resources in part of Ukwuani local government area of Delta State, Nigeria

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Vertical electrical sounding data were acquired from 12 locations evenly distributed around Obiaruku town and her environs. This is an attempt to obtain useful information on the aquifer distribution within the area and hence delineate possible depths boreholes could be drilled for portable and sustainable water supply. Based on the geoelectric section which is in agreement with the driller's log, two near surface aquifers have been identified. The first aquifer consist fine-grained sand formation at a depth between 10.00 – 30.00 m and thickness between 10.00 and 25.00 m. The second aquifer consist medium-grained sand formation and occurs at a depth, between 20.00 – 45.00 m. The study revealed Obiaruku town and her environs as an extensive sandy unit; hence, the aquifer is not confined. Prospective groundwater exploration is therefore recommended in the second aquifer at a depth, between 20.00 – 45.00 m to enhance sustainable and portable water supply in Obiaruku town and her environs.

Key words: Vertical electrical sounding, groundwater potential, aquifer, Obiaruku, wire road, Obinomba, Umukwata, Umutu, Michelin road, drillers log and geoelectric section.

INTRODUCTION

This work was carried out to establish a baseline geophysical data and hydrological characteristics using the Schlumberger arrangement (a vertical electrical sounding) and drillers log from the study area. The vertical electrical method was chosen for this study because the instrumentation is simple; field logistics are easy and straightforward and the analysis of data is less tedious and economical (Oseji et al., 2005; okwueze et al., 1996; shichter, 1933; Whitely 1973). The resistivity method was used successfully in investigating groundwater potential. Oseji et al. (2005) used the method to investigate the aquifer characteristics and groundwater potential in Kwale, Delta State, Nigeria. Oseji et al. (2006), also used the method to determine the groundwater potential in Obiaruku and its environs. Okwueze et al. (1996) used the same method to explore for groundwater in a sedimentary environment. Okwueze et al. (1996) used the method to determine the groundwater potential at Obudu basement area.

MATERIALS AND METHODS

A total of 10 locations, spaced 2.00 km apart were established and surveyed for 80 vertical electrical soundings using a method whereby readings were taken automatically and the results were averaged continuously with an ABEM SAS 300 terrameter and a maximum current electrode spacing of 316 m. In this method, a fixed point called the VES station was marked and noted; two current electrodes (C_1C_2) of equal distance on the opposite sides of the VES station were measured and driven into the ground with the aid of a sledge hammer for proper contact to be made with the ground.

Similarly, two other electrodes called the potential electrodes (P_1P_2) of equal distance and between the current electrodes were measured and driven into the ground with the aid of the sledge hammer. The arrangements of the current and potential electrodes were in such a way as to maintain a straight line. These pair of electrodes was connected to the Terrameter through points AB and MN as shown in Figure 1.

The Terrameter was switched "ON" and current was introduced artificially into the earth through the pair of electrode (C_1C_2) and the resulting potential difference due to the current were measured through the other pair of electrode (P_1P_2), thereafter, the Terrameter was switched "OFF". The current electrodes were moved equally away on the opposite sides of the fixed point according to the designed acquisition parameter $C_1C_2 \geq 5P_1P_2$ and the readings were recorded at every new position. (Oseji et al., 2005; Okolie et al., 2005; Osemeikhian and Asokhia, 1994; Jakosky, 1950; Shichter, 1933; Bhattacharya et al., 1968).

The field procedure consists of expanding current electrodes (C_1C_2) while holding potential electrode's distance (P_1P_2) fixed. This process yields a rapidly decreasing potential difference across P_1P_2, which ultimately exceeds the measuring capabilities of the instrument. At this point, a new value for potential distance was established, typically five times greater than the proceeding value

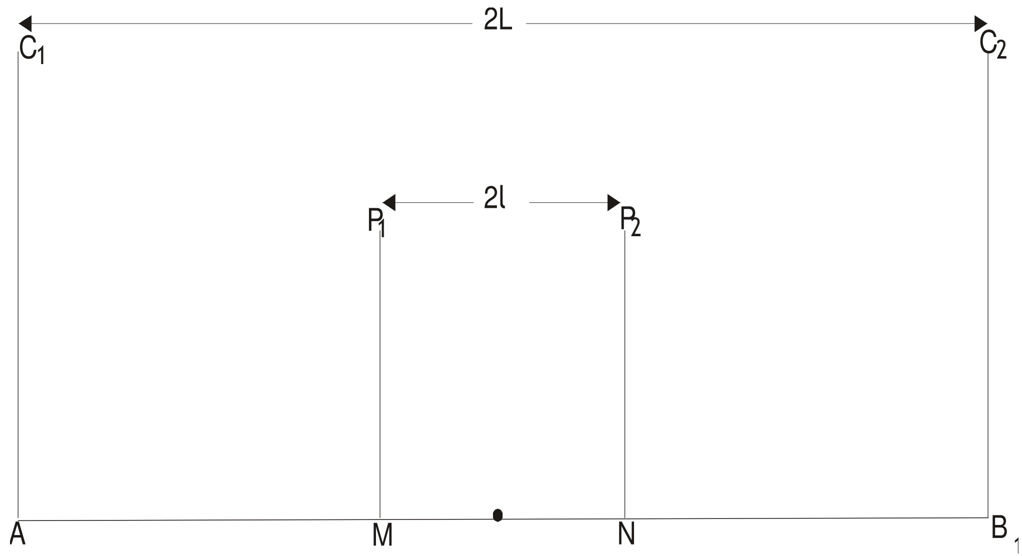

Figure 1. The Schlumberger array configuration (Whitely, 1973).

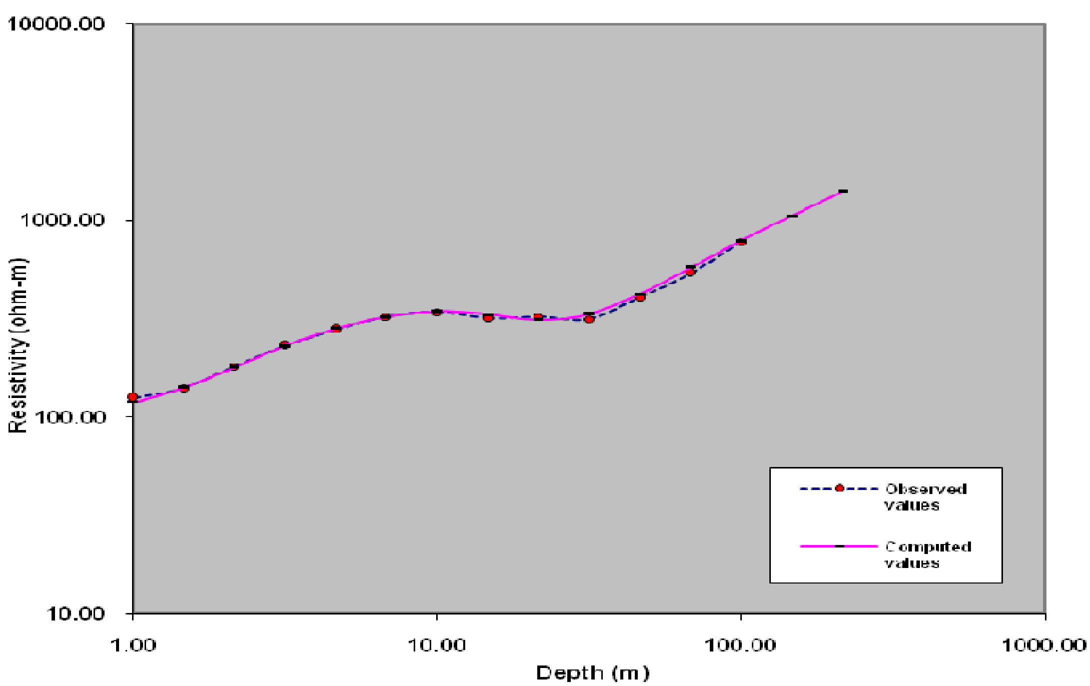

Figure 2. Field data, theoretical curve and the layer model of wire Road, Obiaruku.

and the survey was continued (Keller and Frischknecht, 1966; Osemeikhian and Asokhia, 1994).

The systematic movement of the current and potential electrodes continued until the survey was completed (Harold, 1980).

RESULTS AND DISCUSSION

Obiaruku and environs is within the coastal plain sand deposit. Qualitative analysis of the curves by inspection revealed that the area has KA type curve in wire road, AA in Obinomba, K in Umukwata, A and HA in Umutu mixed secondary school and Michelin road in Umutu as shown in Figures 2, 3, 4, 5, 6 and 7 respectively.

The interpreted sounding curves at locations in Wire road, Obinomba, Umukwata, Adonishaka, Mixed Secondary School, Ghana Quarters and Michelin road in Umutu

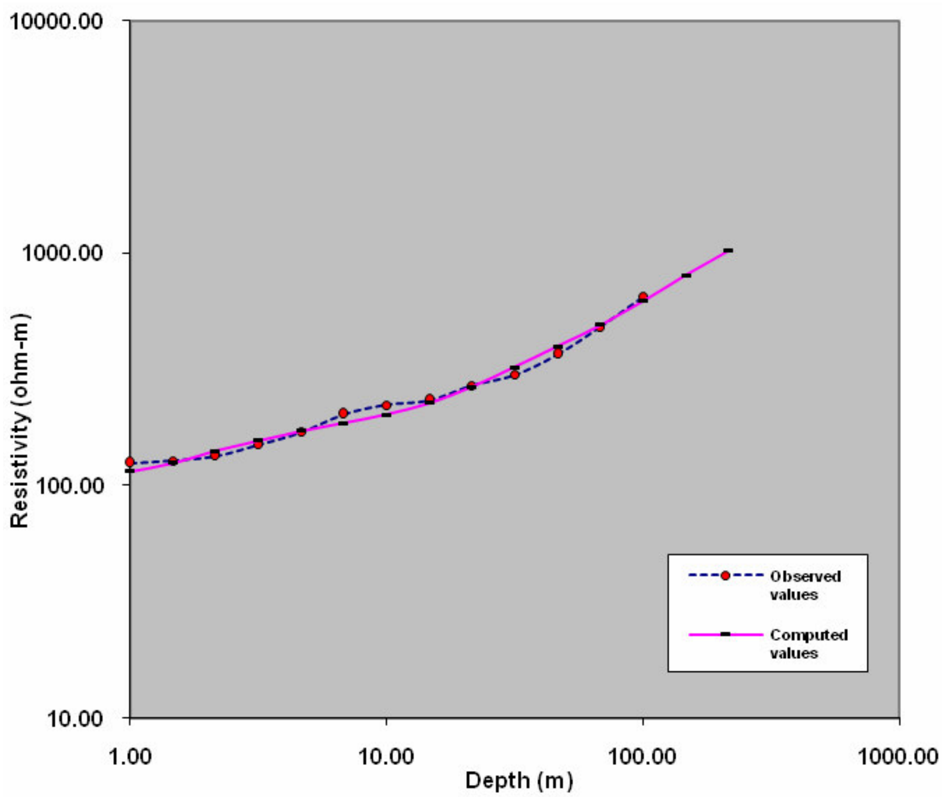

Figure 3. Field Data, theoretical curve and the layer model of New Sapele/Agbor Road Obinomba.

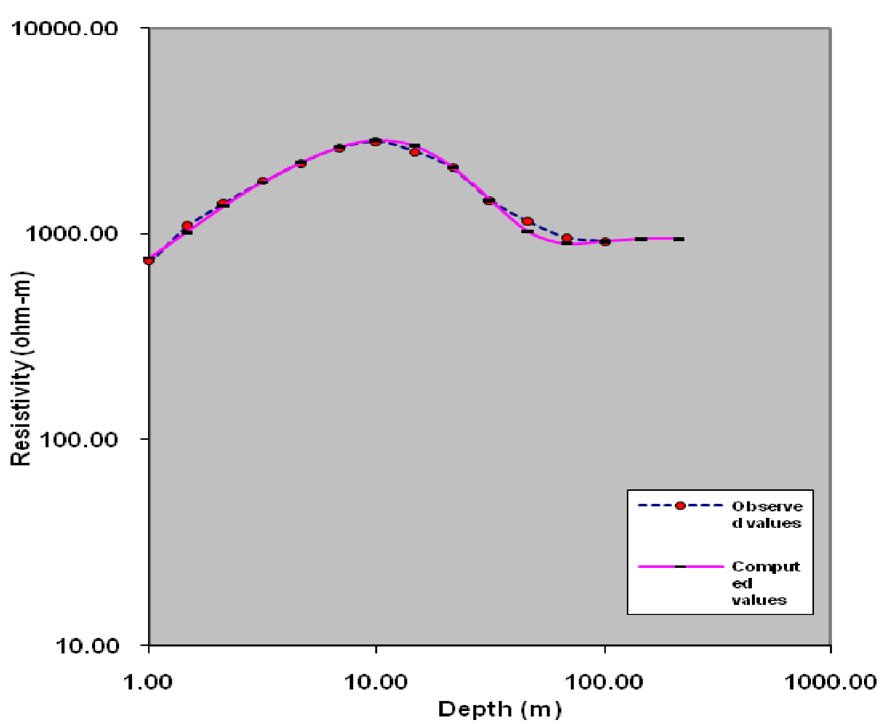

Figure 4. Field data, theoretical curve and the layer model of Umukwata off New Sapele/Agbor road.

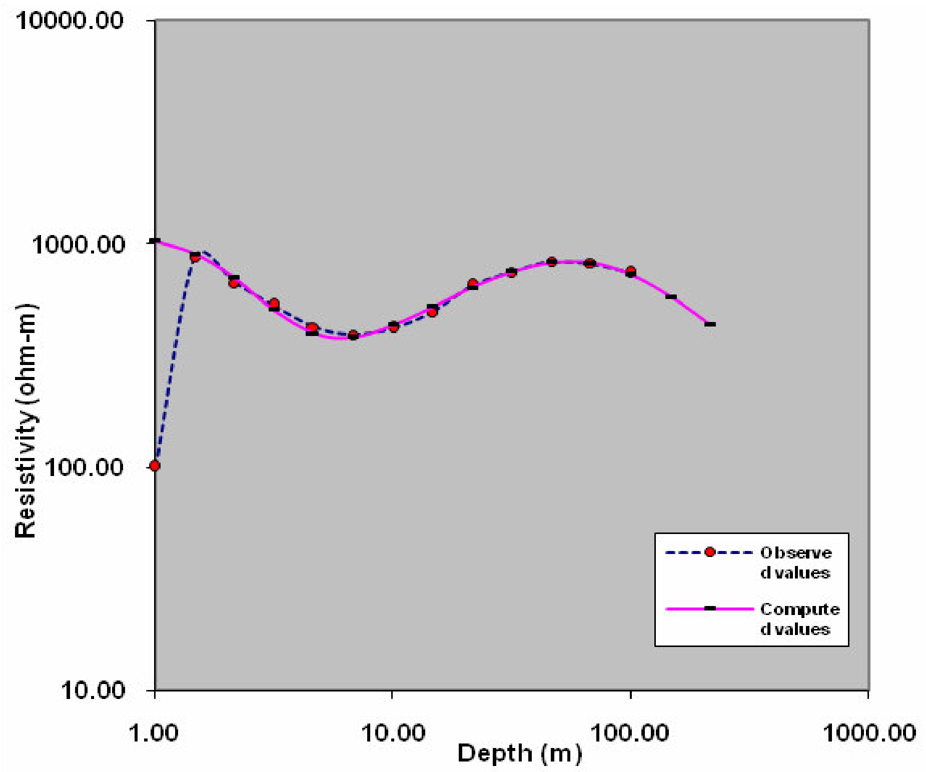

Figure 5. Field Data, theoretical curve and the layer model of Adonishaka in Ebedei, Adonishaka Ebedei, showing observed (field) and theoretical resistivity data curves; and interpreted layer model parameters.

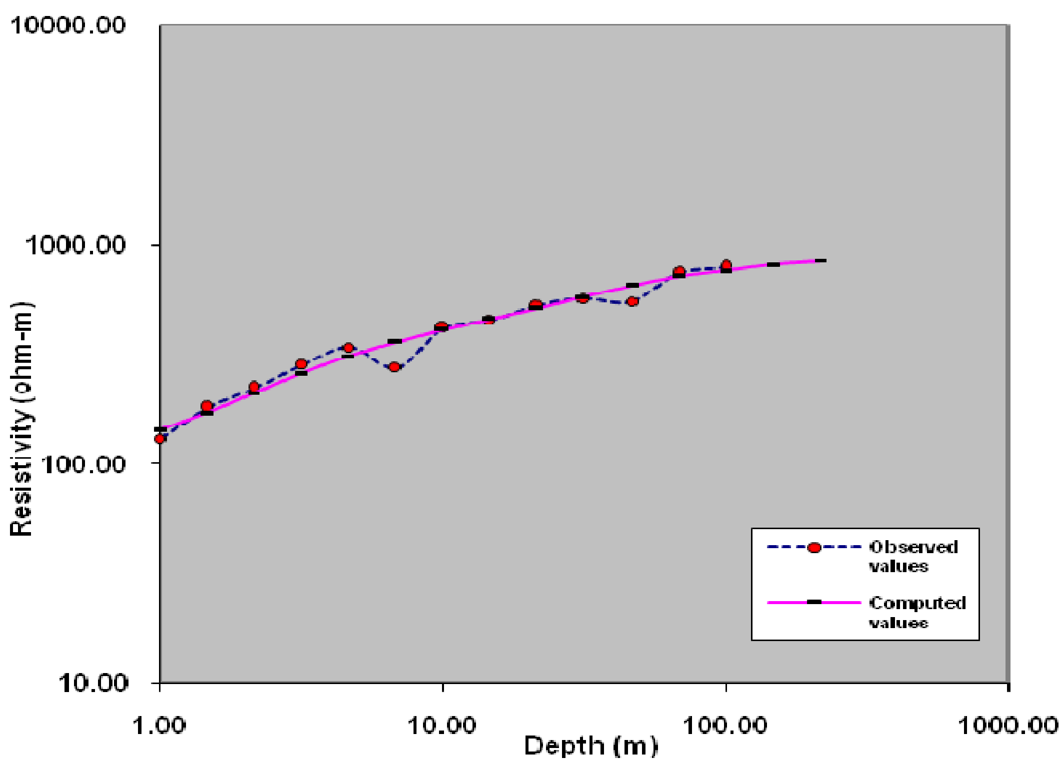

Figure 6. Field data, theoretical curve and the layer model of Umutu Mixed Secondary School.

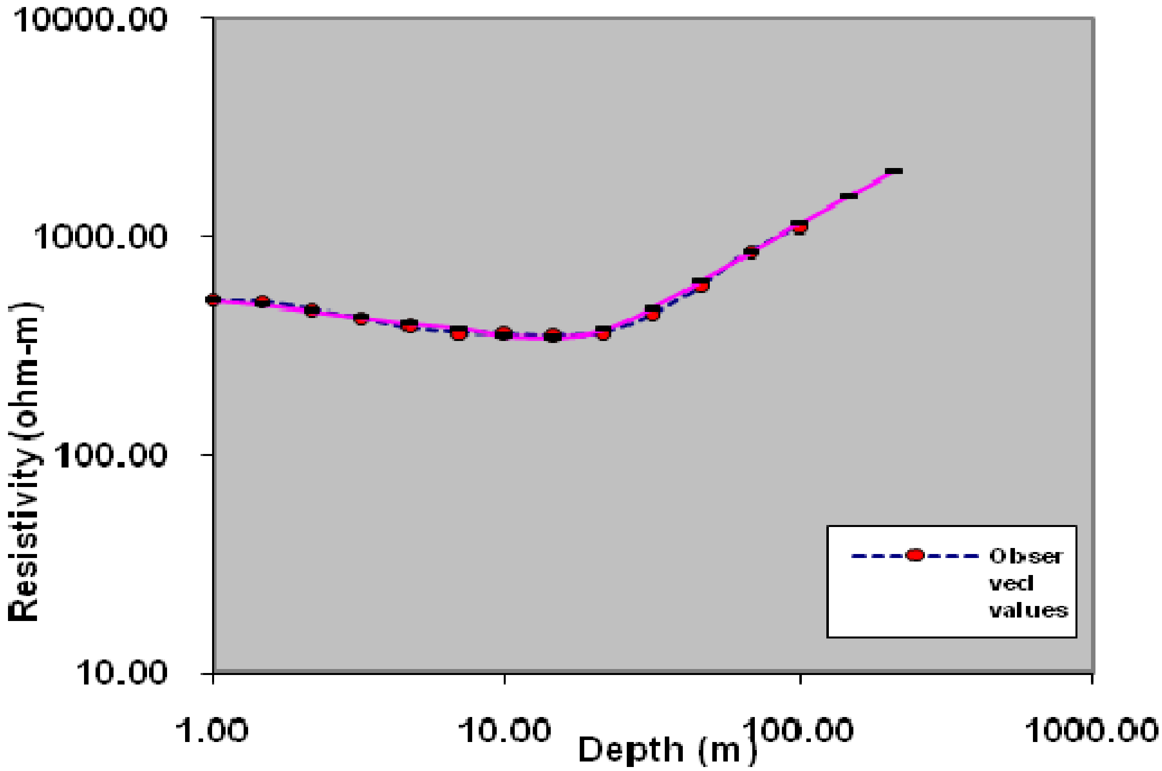

Figure 7. Field Data, theoretical curve and the layer model of Michelin road Umutu in a step function.

shown in Figure 8 VES 26, 27, 28, 29, 30, 31 and 32 generally revealed 4 relevant geoelectric layers with the exception of Adonishaka in Ebedei that has a fifth layer.

The first geoelectric layer is the top soil with resistivity values ranging from 100.00 – 400.00 Ω m and thickness of between 0.50 – 5.00 m. It consist decomposed organic materials which is responsible for the high resistivity values obtained in Obiaruku. The second geoelectric layer consist silt materials and red lateritic soil. It has a thickness of about 0.50 – 15.00 m and resistivity values of between 33.00 – 400.00 Ω m. The third geoelectric layer consist fine-grained sand with a thickness range between 10.00 - 45.00 m at a depth between 10.00 – 20.00 m. This is the first aquifer but not an encouraging trend for viable groundwater prospects. Although the sand layer contains water, it will not be a reliable aquifer because the area has high conductivity, which implies impure or brackish water and in areas within Adonishaka and Umutu, the thickness of this aquifer is not encouraging for sustainable groundwater development.

The fourth geoelectric layer corresponds to the medium-grained sand. This is the second and best aquifer for groundwater development. The thickness is undefined except at Adonishaka that has a thickness of 70.00 m. The depth to this aquifer ranged from 20.00 m at Adonishaka to 45.00 m in every other location within Obiaruku.

The fifth layer is only in Adonishaka. It has a high conductivity diagnostics of either clay or brackish water. The lithologic log from a borehole drilled in Ghana quarters is in agreement with the result of the result of the research.

From the above analysis, two basic surface aquifers have been identified. The first aquifer consist fine-grained sand formation at a depth between 10.00 – 30.00 m and thickness between 10.00 and 25.00 m. The second aquifer consist medium-grained sand formation and occurs at a depth between 20.00 - 45.00 m.

Since aquifer is an underground flood, it could be concluded that the aquifers within Obiaruku and environs act as recharge to river Ethiope as long as the aquifers are not confined.

Conclusion and Recommendations

The study revealed obiaruku town and her environs as an extensive sandy unit. The interpretation indicates that the water-bearing formation (medium-grain to coarse grained sand formations) within the sandstone unit is between the range 20.00 – 45.00 m deep. The result of the interpreted data correlates well with the lithologic log from a nearby borehole.

This depth has an average thickness of 35.00 m and it coincides with the fourth relevant geologic layer in Obiaruku town and her environs. This layer is the best formation within which an appreciable quantity of water for sustainable groundwater development could be obtained.

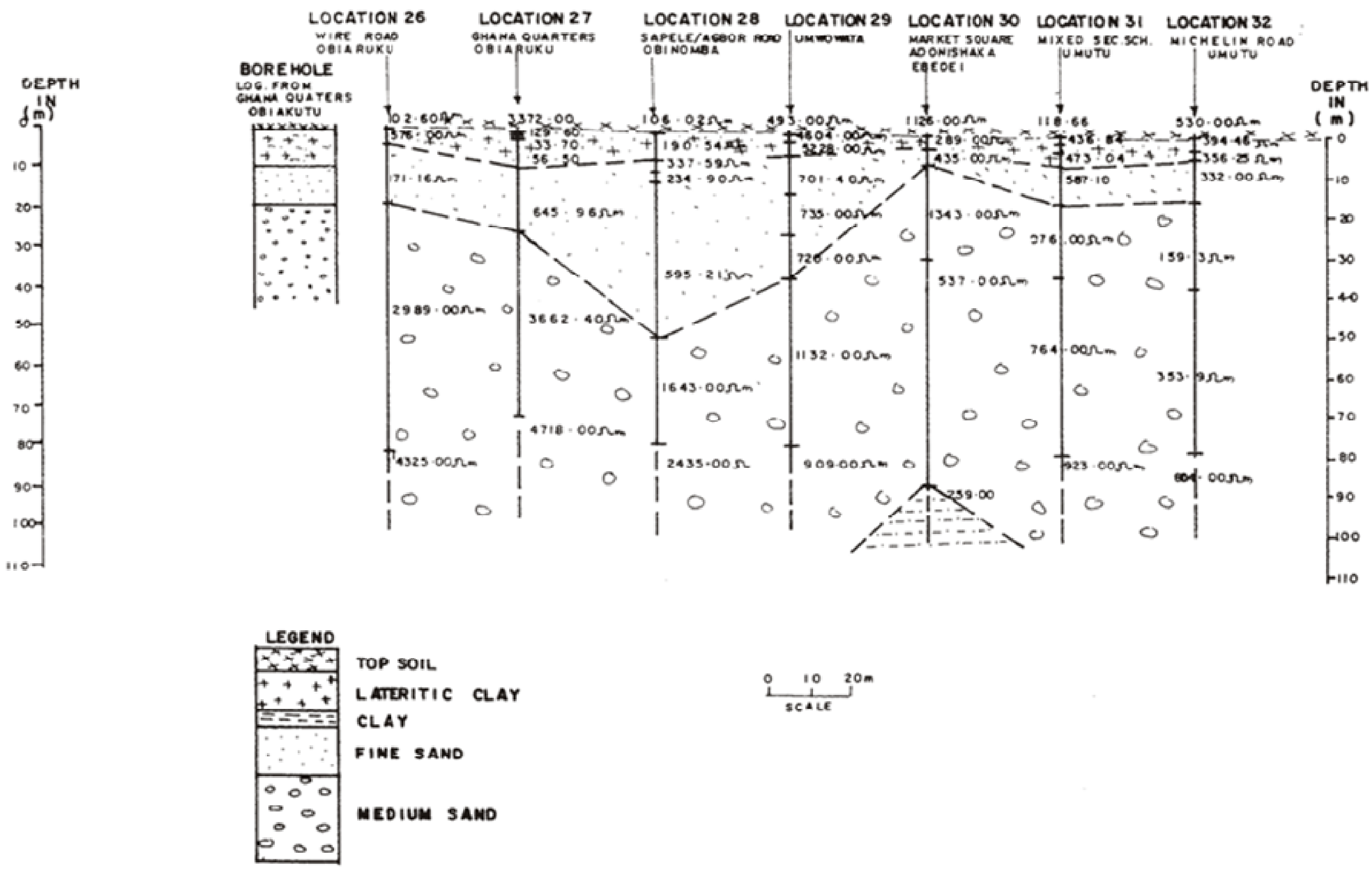

Figure 8. Geoelectric section of Obiaruku town and her environs.

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Appendix

Appendix. Field measurements and data interpretations by Oseji Julius Otutu.

Observed (field) and computed (theoretical) data				Model parameters		
AB/2 Values (m)	Observed Values (ohm-m)	Computed Values (ohm-m)	Geoelectric layer	Resistivity (ohm-m)	Thickness (m)	Cumulative thickness (m)
1.00	125.00	118.70	1	102.60	0.95	0.95
1.47	140.00	141.42	2	576.00	4.18	5.10
2.15	179.90	178.92	3	171.16	14.53	19.66
3.16	229.90	228.25	4	2989.00	61.33	80.99
4.64	277.10	280.74	5	4325.00	infinity	infinity
6.81	323.90	324.34	RMS error	1.37%		
10.00	340.40	343.32				
14.70	319.90	331.55				
21.50	324.30	313.50				
31.60	315.20	334.07				
46.64	405.60	421.83				
68.10	539.00	575.10				
100.00	777.50	787.48				
147.00	1071.80	1053.64				
215.00	1393.90	1405.48				
1.00	125.00	115.47	1	106.02	0.82	0.82
1.47	128.00	125.05	2	190.54	7.30	8.12
2.15	134.00	140.64	3	337.59	3.18	11.25
3.16	150.00	156.70	4	234.90	2.95	14.20
4.64	170.00	171.63	5	595.21	38.17	52.37
6.81	203.00	185.69	6	1643.00	26.23	78.60
10.00	223.00	202.35	7	2435.00	infinity	infinity
14.70	233.00	227.45	RMS error	2.41%		
21.50	269.00	266.05				
31.60	300.00	322.08				
46.64	367.00	395.80				
68.10	481.00	492.10				
100.00	649.00	623.61				
147.00	841.00	802.26				
215.00	1074.00	1024.22				
1.00	730.00	766.11	1	493.00	0.58	0.58
1.47	1080.00	1017.69	2	4604.00	3.16	3.74
2.15	1400.00	1361.22	3	5228.00	2.99	6.73
3.16	1800.00	1778.71	4	701.40	11.48	16.27
4.64	2200.00	2223.70	5	735.00	7.48	25.66
6.81	2600.00	2624.91	6	720.00	10.95	36.64
10.00	2800.00	2835.30	7	1132.00	41.93	78.57
14.70	2500.00	2667.54	8	909.00	Infinity	Infinity
21.50	2100.00	2111.39	RMS error	1.88%		
31.60	1450.00	1448.14				
46.64	1149.00	1025.39				
68.10	962.00	903.65				
100.00	922.00	922.58				
147.00	950.00	949.24				
215.00	916.00	949.91				

Appendix. Contd.

1.00	100.00	1031.46	1	1126.0	1.05	1.05
1.47	869.00	901.91	2	289.00	2.98	4.03
2.15	667.00	704.70	3	435.00	4.20	8.23
3.16	532.00	508.25	4	1343.0	23.71	31.94
4.64	424.00	396.42	5	537.00	56.13	88.06
6.81	392.00	381.76	6	259.00	infinity	infinity
10.00	419.00	432.69	RMS error	1.36%		
14.70	497.00	524.09				
21.50	651.00	638.07				
31.60	749.00	753.02				
46.64	831.00	828.06				
68.10	816.00	823.74				
100.00	740.00	729.36				
147.00	597.00	578.81				
215.00	436.00	434.16				