GEOPHYSICAL AND PHYSICO-CHEMICAL CHARACTERISTICS OF GROUNDWATER IN ALAPOTI AND ITS ENVIRONS, SOUTHWESTERN NIGERIA

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Abstract

Electrical resistivity method involving the 2-D surveying was carried out within the sedimentary complex terrain of Alapoti, Southwestern Nigeria with a view of estimating the geo electric layer parameters to identify the aquifer types, evaluate the groundwater potential and overburden protective capacity over the aquifer. (63) 2-D electrical resistivity readings were taken around the area using the Wenner Beta array. The preliminary layer parameters obtained were forward modelled using the win resist software to obtain the final layer parameters, and pseudo sections were created. Five traverses were covered. Each traverse was 100m long and were taken in the West–East direction in Alapoti. The underground geochemical parameters were determined and the data were subjected to statistical analysis. Fresh water/Aquifers/Surface water is encountered at depth ranging from 1.25m to 9.26m with thickness ranging from 2,5m to 8.01m. The location of the fresh water/ surface water/aquifer is indicated in the pseudo section. The water is slightly acidic with pH ranging from 4.28 to 5.22, while Ca^{2+}, Mg^{2+}, K^{+} are below the W.H.O recommendation. The average values for the Sodium Adsorption Ratio, Soluble Sodium Percent, Magnesium Adsorption Ratio, Kelly's Ratio, Permeability Index, and Residual Bicarbonate were 5.3, 12.16, 36.4, 2.28, 6.28, 3.72 respectively and all of them except Permeability index are below the recommended values. The groundwater is slightly acidic with relatively shallow depth, odourless, potable and good for irrigation purposes.

Key words: 2–D Resistivity, Alapoti, aquifer, irrigation, portability.

INTRODUCTION

The largest available source of fresh water lies underground and is referred to as groundwater (Ariyo *et al.*, 2005) and it accounts for about 98% of the world's fresh water (Buchanan, 1983; Bower, 2002). The quality required of ground water supply depends on its purpose or intended use. (Todd, 1980; 1986). The basic purposes for which water is domestically required include; drinking, bathing, cooking, and general sanitation such as laundry, flushing of closets and other household chores, whereas for agricultural purposes is for irrigation. Therefore, an assured supply of water both qualitatively and quantitatively for these purposes greatly improves the social, economic and agricultural activities of the people.

Alapoti and its environs have witnessed an upsurge in infrastructural development and increase in human population. Hence, the demand for potable water for human consumption and agriculture has grown astronomically over the years. The successful exploitation of sedimentary terrain groundwater requires a proper understanding of its Geo-hydrological characteristics, Hence, any drilling programme for underground development in areas of sedimentary terrain is generally preceded by detailed hydro geophysical investigation.

The use of electrical resistivity method in geological mapping and in search for groundwater is becoming increasingly successful during the last two or three decades, the scope of application includes tracing of lithological boundaries between concealed rocks of deferring electrical properties, location of faults and fracture zones, delineation of dykes, volcanic and meta sedimentary belts, groundwater exploration , etc (Olayinka and Olorunfemi 1999; Omosuyi et al, 2003).Groundwater has been investigated extensively both in basement and sedimentary terrains using this method(Satpathy and Kanungo, 1976; De Beer and Blume, 1985;Olayinka and Olorunfemi, 1992; Olorunfemi et al, 1993; Shemang, 1993; Omosuyi, 2000).

Measurement of the electrical resistivity of the earth has been employed as a tool for groundwater exploration and also for geological mapping due to its high resolution of near surface materials and the ease of operation of the equipment (Zohdy et al, 1974; Carruthers, 1985). These include aquifer delineation, saline water mapping, lithological boundary differentiation and structural trends among others (Overmeeren, 1981; Olorunfemi and Opadokun, 1986).

As the demand for groundwater grows due to the increase in population and agricultural activities in the area, a detailed hydro geophysical investigation coupled with the determination of the physio chemical characteristics of the underground water in Alapoti area is necessary. This investigation utilised hydrogeological and geo electrical characteristics of the sedimentary terrain to determine future groundwater development at Alapoti and its environs in order to evaluate the quality of groundwater from both Hand dug Wells and Borehole in the area. It particularly aims at determining the domestic and agricultural usability of the water.

Geological Setting

Alapoti and its environs is located in the South-western part of Nigeria and falls within the Dahomey Basin (Figure1). The Dahomey Basin is a combination of inland/coastal/offshore basin that stretches from southeastern Ghana through Togo and the Republic of Benin to southwestern Nigeria. It is separated from the Niger Delta by a subsurface basement high referred to as Okitipupa Ridge. Its offshore extent is poorly defined. Sediment deposition follows an east-west trend. In the republic of Benin, the geology is fairly well known. In the onshore, cretaceous strata are about 20m thick. A non-fossiliferous basal sequence rests on the Precambrian basement. This is succeeded by coal cycles, clays and marls which contain fossiliferous horizons. Offshore, a 1000m thick sequence consisting of sandstones followed by black fossiliferous shale towards the top has been reported. This was dated by Billman (1976) as being pre-Albian to Maastrichtian. The cretaceous is divisible into two geographic zones, north and south. The sequence in the northern zone consists of a basal sand that progressively grades into clay beds with intercalations of lignite and shales. The uppermost beds of the Maastrichtian are almost entirely argillaceous. The southern zone has a more complicated stratigraphy with limestone and marl beds constituting the major facies. Sedimentation in the northern zone which is located inland and close to the basin periphery, began during the Maastrichtian when a thin sequence (<200m) of unconsolidated sands, grits, silts, clays and shales, was deposited. This sequence rests on the basement; the transitional facies is marked by a conglomerate or white to grey sandy and kaolinitic clays derived as degradation products from the surrounding Precambrian rocks. In the southern zone, which is coastal and offshore, the oldest sediments consist mainly of loose sand, grits, sandstones and clay with shale interbeds which progressively grade into shale. They are late Albian and possibly Neocomian in age (Omatsola and Adegoke, 1981). The basal conglomerates have been reported from outcrops and boreholes (Jones and Hockey, 1964). The onshore sequence towards the basin periphery in Nigeria correlates well with the Maastrichtian onshore in the republics of Benin and Togo. The geology of Togo sector is very similar to that of Nigerian and Benin sectors. The cretaceous succession shows marked lithological changes which have been expressed in terms of formal and informal lithostratigraphic nomenclature by previous workers. This can lead to dual or multiple nomenclature and thus confusion.

Among the major lithostratigraphic units of the eastern Dahomey basin are the Araromi, Ewekoro, and Akinbo formations. The Dahomey basin is one of the sedimentary basins on the continental margin of the Gulf of Guinea, extending from southeastern Ghana in the west to the western flank of the Niger Delta (Jones and Hockey, 1964; Omatsola and Adegoke, 1981. The basin is bounded in the west by faults and other tectonic structures associated with the landward extension of the fracture zone. Its eastern limit is similarly marked by the Hinge line, a major fault structure marking the western limit of Niger Delta (Adegoke, 1969; Omatsola& Adegoke,1981). It is also bounded in the north by the Precambrian basement rock and the Bright of Benin in the south (Figure 1).

Stratigraphic studies of Dahomey basin were conducted by various researchers among whom are Jones and Hockey, (1964); Adegoke, (1975); Omatsola and Adegoke, (1981). The general sequence for the rock unit from the top are the Coastal plain sands, Ilaro formation, Oshosun formation, Akinbo formation, Ewekoro formation, and Abeokuta formation lying on the Southwestern Basement Complex of Nigeria (Figure2).

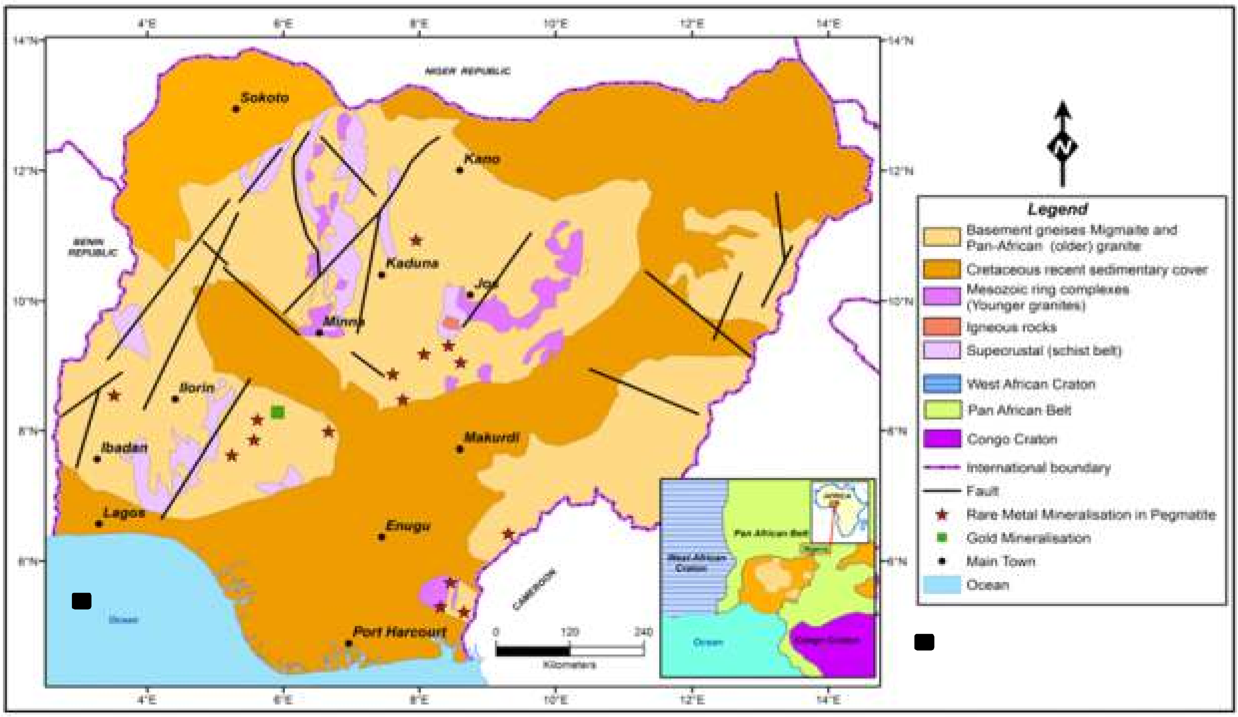


Figure 1: Generalized geological map of Nigeria showing the location of study (Nigerian Geological Survey Agency, 2004)

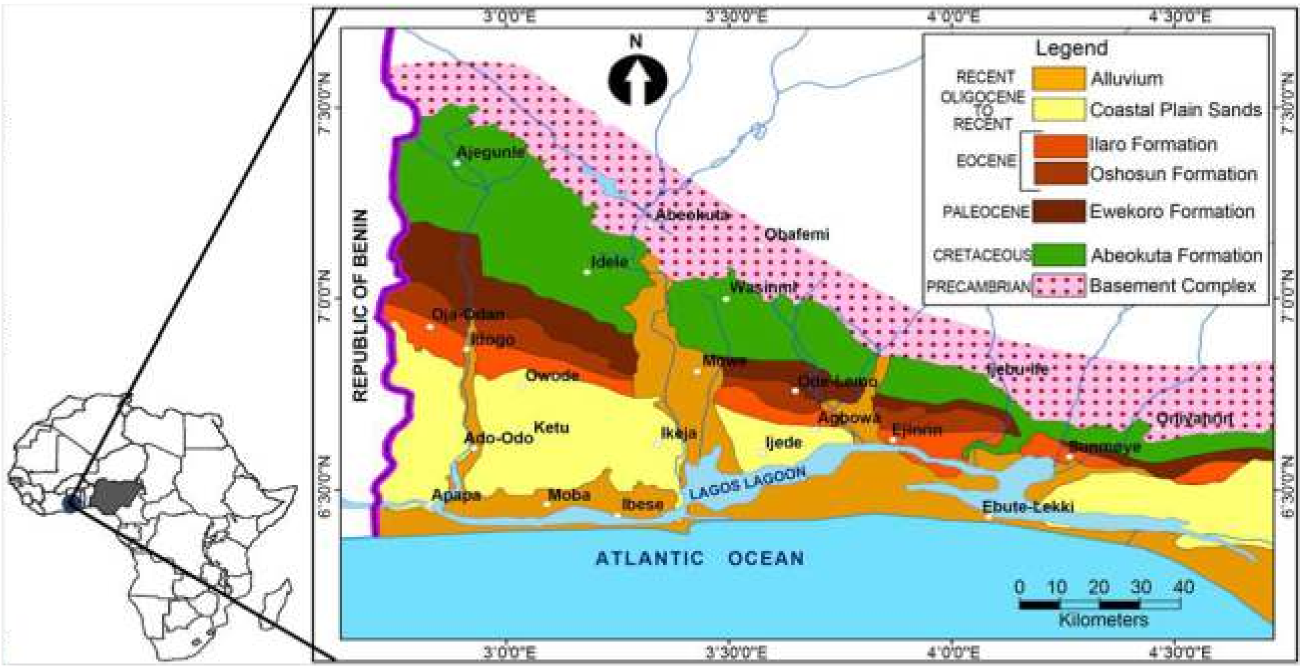


Figure 2: Map of Eastern Dahomey basin showing the stratigraphic setting (Modified after Gebhardt et al. 2010)

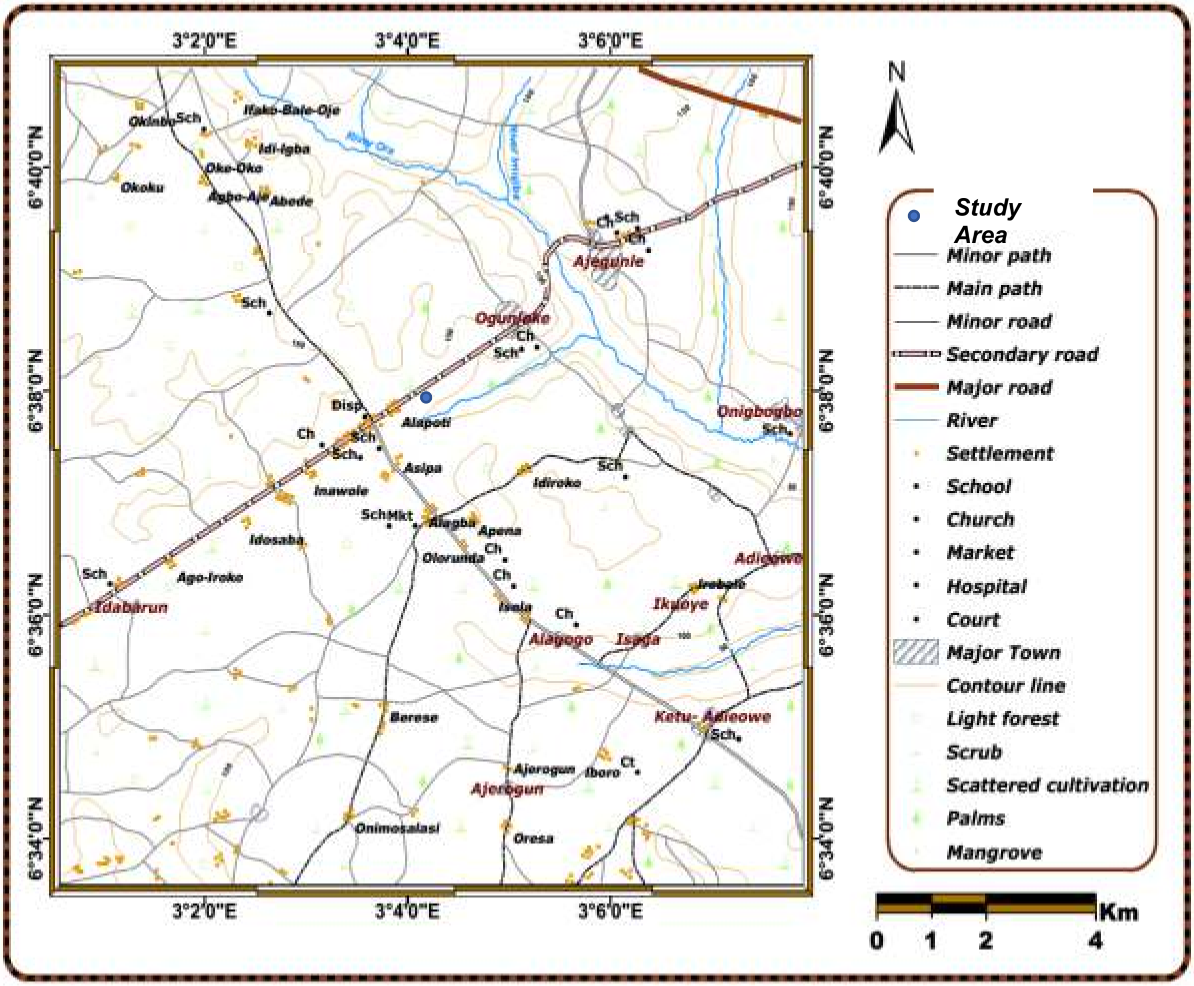


Figure 3: Location map of Alapoti and its Environs

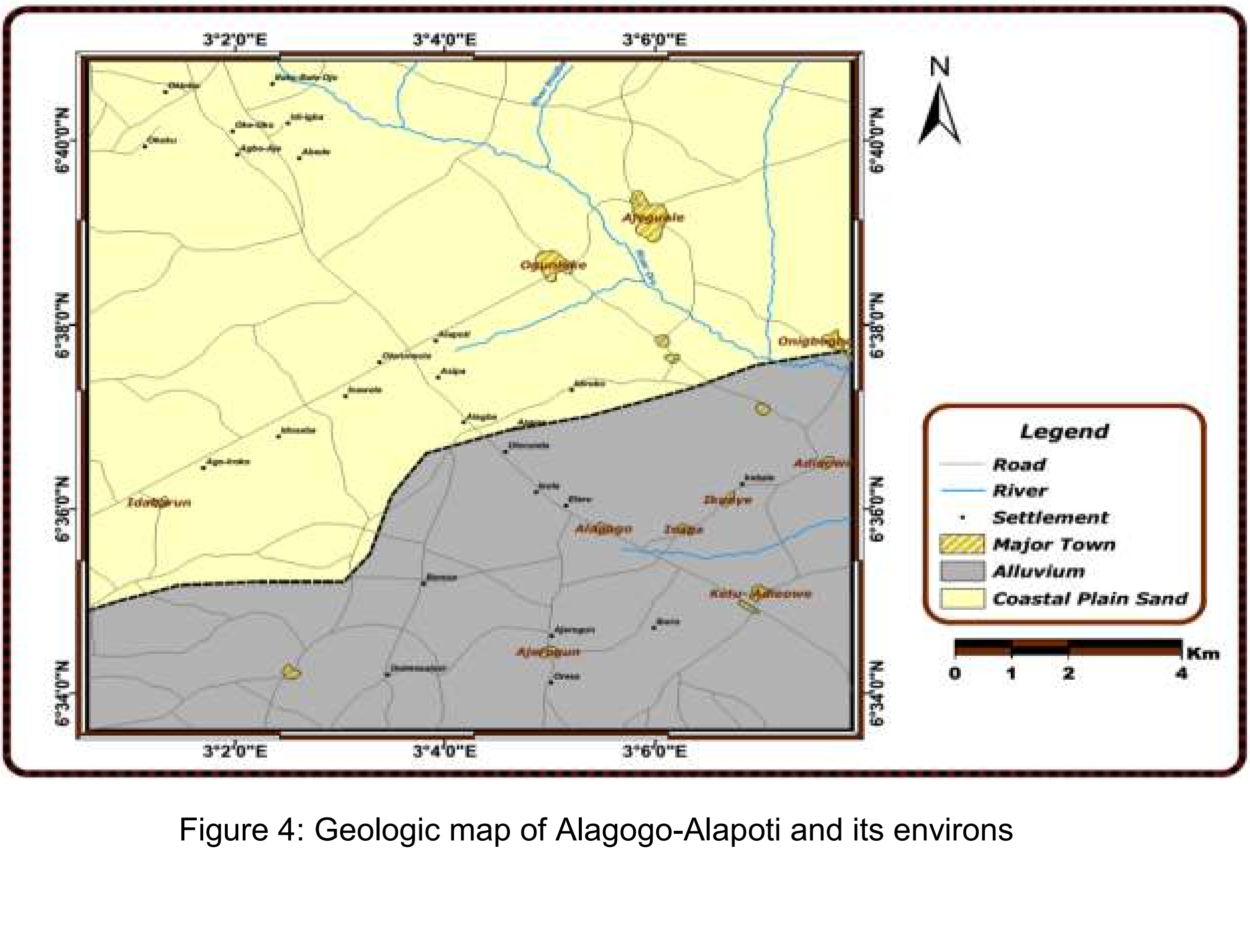


Figure 4: Geologic map of Alagogo-Alapoti and its environs

METHODOLOGY

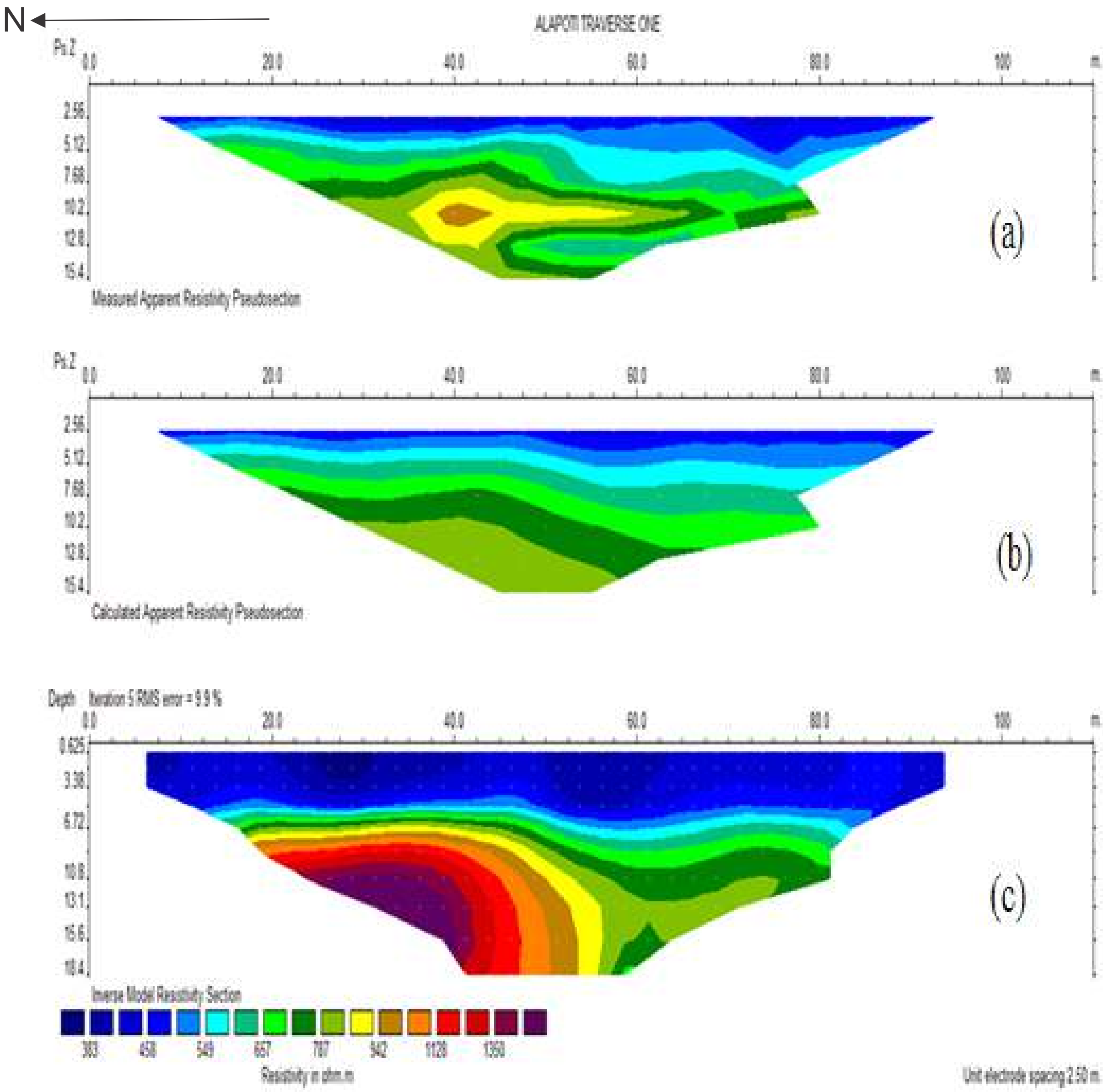
Two-dimensional resistivity surveys using Wenner arrangement were carried out with a number of electrodes connected to a cable to Multi AbemTerrameter.The smoothness-constrained least squares method was employed. For Wenner arrays the depth of investigation is about 0.5 times the electrode spacing.

Water samples were collected from shallow hand-dug wells and boreholes for sampling. Sampling points were geo-located with the use of a Global Positioning System (GPS). The plastic bottles that were used for sampling were firstly cleaned with distilled water. At the point of sampling, the bottles were rinsed with the sampling media at each point and samples were collected into airtight plastic bottles prior to laboratory analysis at J-Lab Services, Lagos. Physical parameters obtained in-situ includes pH, temperature, total dissolved solids (TDS) and electrical conductivity (EC). These parameters were determined directly on the field using the Milwaukee Portable pH meter Kit. Each water sample is collected in pairs. One pair of samples is acidified with a few drops of concentrated Trioxonitrate (IV) (HNO_3) acid while the other is left untouched. The sample in which HNO_3 is added was analyzed for cations such as sodium, potassium, calcium, magnesium etc while the untouched sample was tested for anions such as chloride, sulphate, silica, phosphate, nitrate and bicarbonate/carbonate. The reason for adding drops of HNO_3 to the samples for cationic analyses was to prevent the molecules of water from adhering to the walls of the sample bottles. The Sodium Absorption Ratio (SAR), Soluble Sodium Percentage (SSP), Residual Sodium Bicarbonate(RSBC), Magnesium Absorption Ratio (MAR) and The Kelly's Ratio (KR) were calculated accordingly

RESULTS AND DISCUSSION

Traverse Line One

Figure 5 shows variation in resistivity along the traverse line with depth. The orientation of the traverse line one is approximately in the north-south direction representing an inverse model resistivity section. The section captured a low resistivity material interpreted to be lateritic clay with resistivity range of 3 Ωm to 549 Ωm at a depth of about 7.0m as the topsoil material (Barker *et al*.,1992 and Kearey *et al*, 2002). The topsoil material consists of moderately consistent layer of thickness of approximately 6.0m. The topsoil underlain by five tiny layers which spread across the traverse, having resistivity values ranging from about 549 Ωm to 722 Ωm, and it is made up of laterite. These layers extend from a depth of 6.50m and beyond. The seventh to twelfth layer form a dome-like structure at northern side of the traverse. It is at a depth of about 8.0m with an apparent resistivity ranging from about 722 Ωm to1350 Ωm indicating the presence of a mixture of lateritic sand and wet sand.

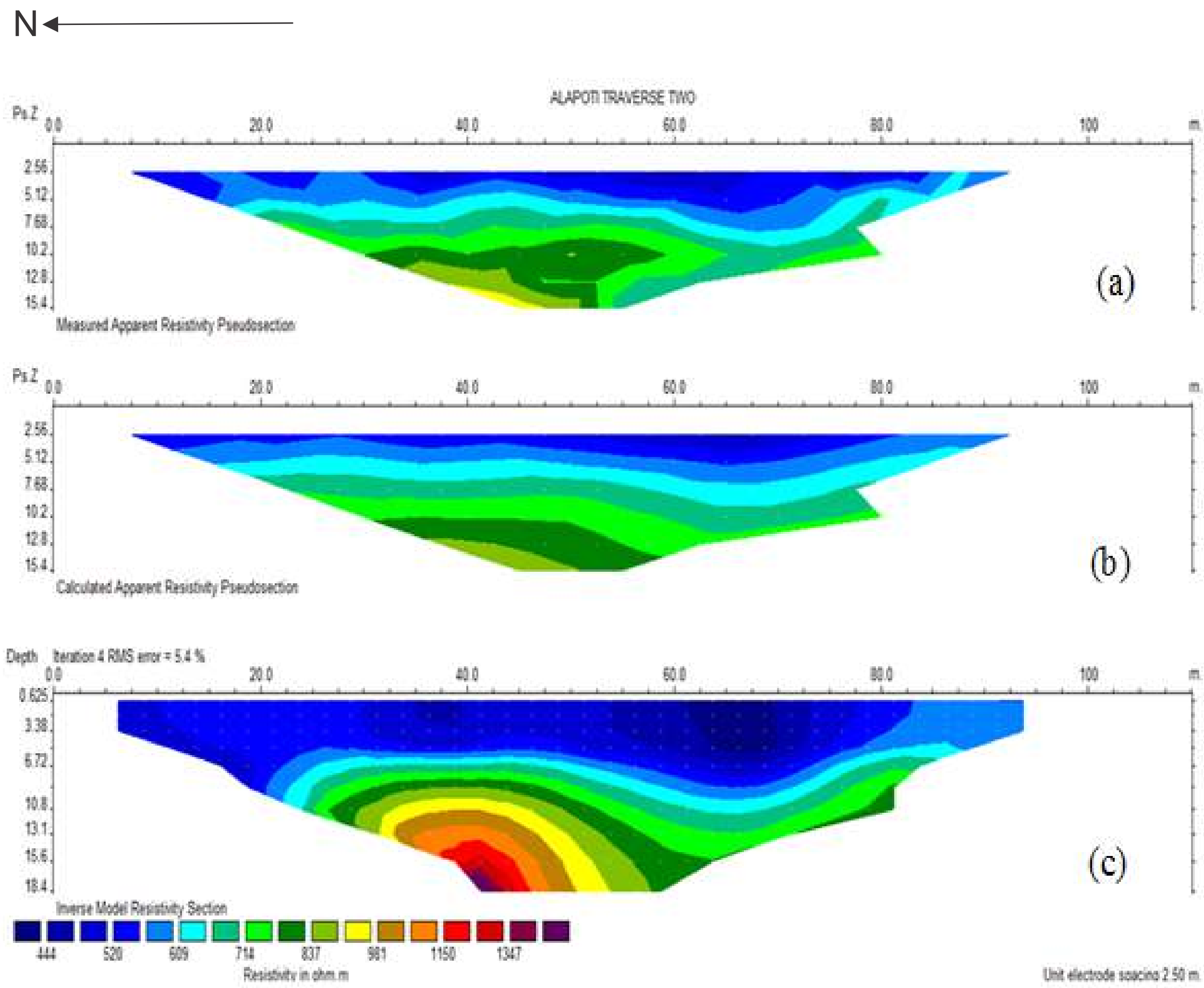


X unit electrode spacing 2.50m Y unit electrode spacing 2.50m

Figure 5 (a)The measured apparent resistivity pseudosection, (b) calculated apparent resistivity pseudosection and (c) inverse model resistivity section for traverse 1.

Traverse Line Two

Figure6 shows the inversed resistivity section for traverse line two with orientation running in the north-south direction. The image line represents the resistivity variation with depth across the line and delineated high conductivity topsoil which is characterized to be lateritic clay with resistivity values range of about 444.0Ωm to 609.0Ωm. at a depth of about 6.50m. The second layer to the eighth layer delineated is presumed to be laterite with resistivity values ranging from 609.0Ωm to1000 Ωm. at a depth of about 8.0m These spread across the traverse. The ninth, tenth and eleventh layers depicts lateritic sand or wet sand with resistivity values ranging from 1,000Ωm to 1400 Ωm. It is found at a depth of about 10.0m forming a dome-like structure within a horizontal distance of about 30.0m



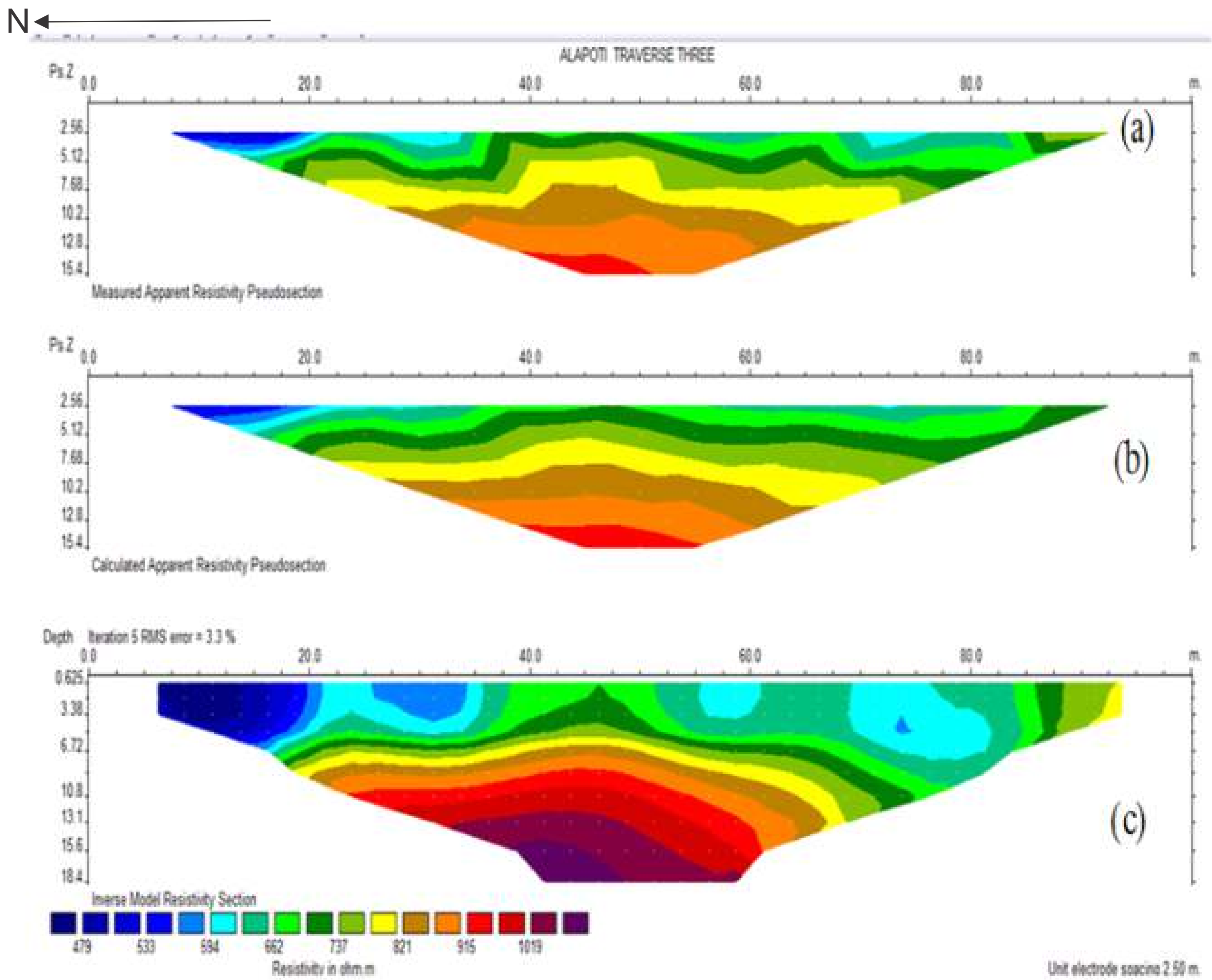
X-unit electrode spacing 2.50m Y unit electrode spacing 2.50m

Figure 6: (a) The measured apparent resistivity pseudo section, (b)calculated apparent resistivity pseudo section and (c) inverse model resistivity section for traverse 2

to52.0m in the northern side of the traverse.

Traverse Line Three

The inversed model resistivity section for traverse line three (Figure7) with orientation approximately in the north-south direction clearly shows pockets of low resistivity material suspected to be lateritic clay which forms the topsoil. It has apparent resistivity values of range 479Ωm to 628Ωm with a depth of about 7.0m. The topsoil material is underlain by high resistive materials of apparent resistivity values of range 628Ωm to 1019Ωm at a vertical distance of 6.72m to13.10m with a depth of about 13.0m. The last layer depicts lateritic sand or/wet sand with apparent resistivity greater than 1019Ωm with a depth of about 15.60m. It slopes northward and southward at the centre of the traverse. The geological descriptions are compared to the approximate resistivity ranges described by (Kearey*et al.,* 2002).



X unit electrode spacing 2.50m Y unit electrode spacing 2.50m

Figure 7 (a)The measured apparent resistivity pseudo section, (b) calculated apparent resistivity pseudo section and (c) inverse model resistivity section for traverse 3.

Traverse Line Four

The inversed model resistivity section along traverse line four (Figure 8) showed the resistivity variation along the traverse line with depth. The low resistive portion on the horizontal distance of about 38.0m to 72.0m which depicts lateritic clay is the top soil. It has an apparent resistivity ranging from about 215.0 Ωm to 494.0Ωm. This is overlain at the extreme north and south of the traverse by a high resistive lateritic material of apparent resistivity above 500.0Ωm. at a depth of about 6.8m Beneath the top soil is a section having resistivity values of range 494.0 Ωm to 1427.0 Ωm, and it indicates lateritic sand with an average thickness of about 6.0m and depth of about 10.80m. Underneath is a layer with apparent resistivity greater than 4,000

Ωm, forming a small spot in the northern side of the traverse at a depth of about 17.50m below the surface which is presumed to be dry sand/porous limestone.

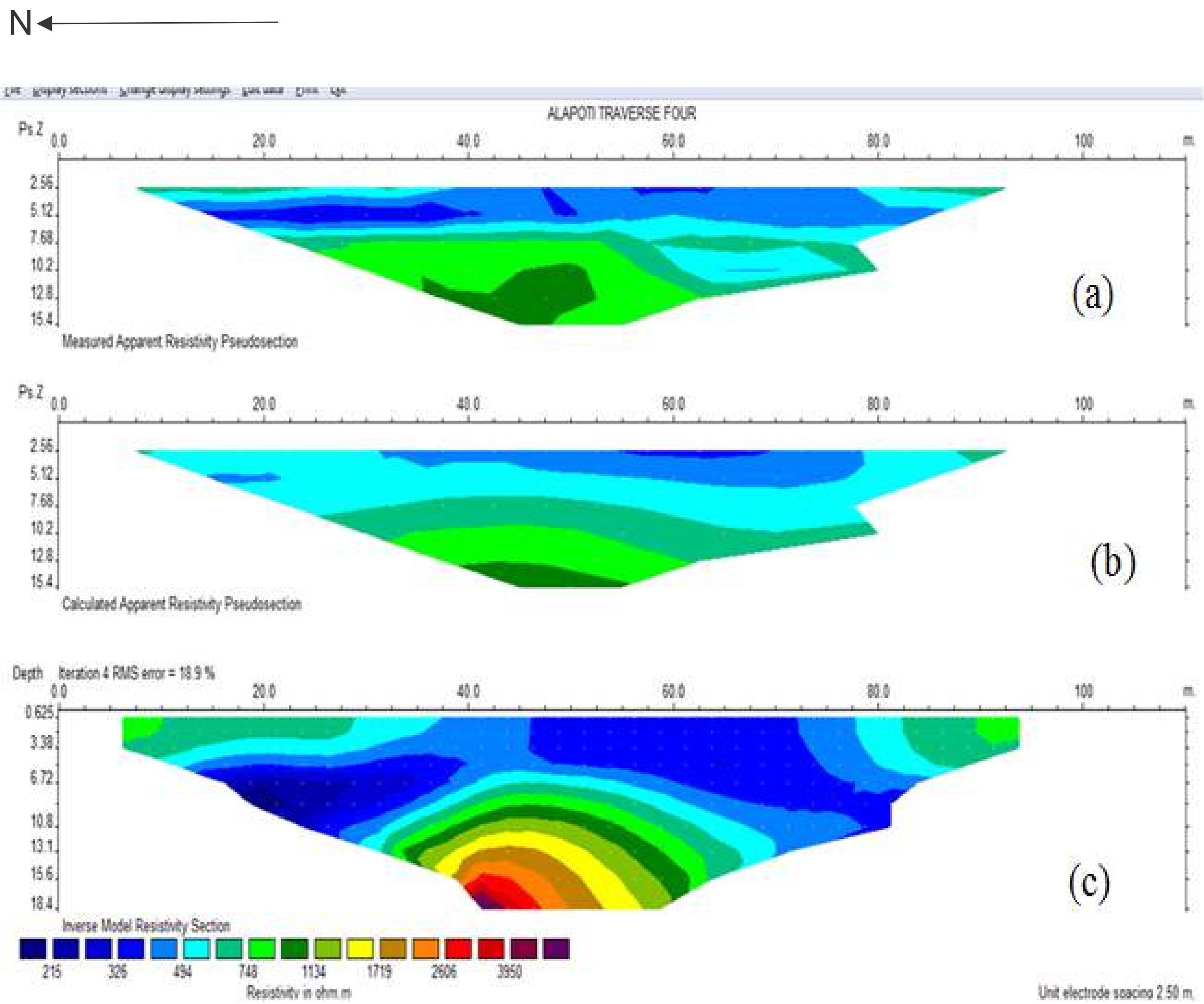
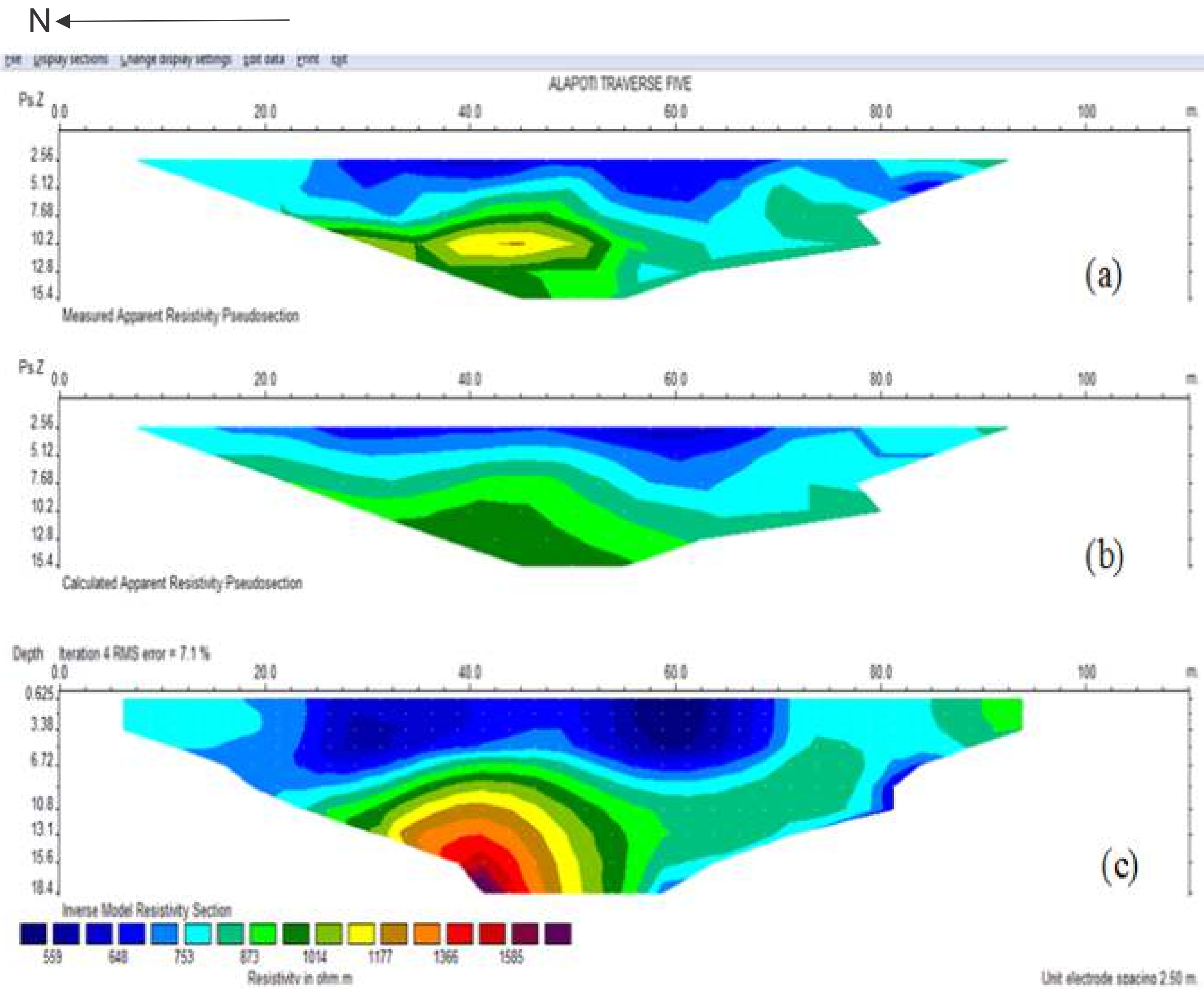


Figure 8 (a) The measured apparent resistivity pseudosection, (b)calculated apparent resistivity pseudosection and (c) inverse model resistivity section for traverse 4.

Traverse Line Five

The inversed model resistivity section for traverse line five (Figure 9) with orientation along the north-south direction of the study area, and the image line show a moderate resistive topsoil material with apparent resistivity values ranging from 559.0Ωm to1014.0Ωm at a depth of about 6.0m. It shows the presence of laterite. Underlain this layer is a high resistive material composed of lateritic sand with apparent resistivity values ranging from 1014.0Ωm to 1,600.0 Ωm.at a depth of about 15.0m. The last layer is composed of a high resistive material made up of dry sand with apparent resistivity greater than 1,500Ωm at a depth of about 17.50m. It appears as a little spot at the northern side of the traverse.



X unit electrode spacing 2.50m   Y unit electrode spacing 2.50m

Figure 9: (a)The measured apparent resistivity pseudosection, (b)calculated apparent resistivity pseudosection and (c) inverse model resistivity section for traverse 5.

Physico-Chemical Characteristics

The results for the various physical parameters such as pH value, Total Dissolved Solids, Temperature and the geological coordinates of the sample locations can be seen in Table 1.

Table 1: Physical parameters of the water samples in Alapoti area

Sample Source	TDS(mg/l)	EC(µS/cm)	Temp. (?C)	pH	Coordinates
HDW_1	22	45	33.7	4.28	N6°37'47.6", E3°2'02.4"
HDW_2	24	47	33.2	4.3	N6°37'37.4" E3° 1'35.7"
HDW_3	29	49	33.6	5.48	N6°37' 31.7" E3° 2'0.49"
HDW_4	28	50	33.1	5.22	N6° 37'28.9" E3° 01'20.2"
BH_5	17	36	33.8	4.8	N6?37' 26.2" E3°01'14.9"
HDW_6	17	37	33.8	4.8	N6?37' 53.0" E3°2' 00.9"

HDW= Hand Dug Well, BH= Borehole

Chemical Assessment

The results for the various cationic and Anionic chemical parameters such as: $Ca^{2+)}$ (mg/l), Mg^{2+}, Na^{2+}(mg/l), K^{+}(mg/l), HCO_{3-} (mg/l) , Cl^{-}(mg/l), Fe^{2+}(mg/l),of the sample locations can be seen in Tables 1 and 2

Table 2: Chemical parameters (cationic and anionic) of the water samples of Alapoti area

Sample source	$Ca^{2+)}$ (mg/l)	Mg^{2+} (mg/l)	Na^{2+} (mg/l)	K^{+} (mg/l)	Mn (mg/l)	Zn^{2+} (mg/l)	PO_{4-} (mg/l)	SO_4^{2-} (mg/l)	Cl^{-} (mg/l)	NO_{3-} (mg/l)	HCO_{3-} (mg/l)
HDW_1	1.22	0.79	22.01	3.60	0.00	0.09	0.00	0.31	46.68	2.07	8
HDW_2	1.27	0.55	4.21	0.31	0.00	0.01	0.00	0.03	21.60	5.12	10
HDW_3	5.30	0.51	6.80	0.20	0.00	0.01	0.07	0.05	18.00	0.04	12
HDW_4	0.33	0.54	4.21	0.32	0.03	0.01	0.01	0.04	18.30	0.10	14
BH_5	1.34	0.85	21.05	3.93	0.03	0.05	0.04	0.23	18.20	1.67	10
HDW_6	0.87	1.01	16.53	2.32	0.01	0.01	0.00	0.56	18.01	10.49	26

Table 3: Summary of the Physico chemical parameters, S.O.N (2007) and W.H.O (2006) standard for potable water

Measured Parameter	Range	Mean	SON (2007) Standard Permissible	WHO (2006) standard	
				Recommended Level	Max. permissible Level
Ph	4.28-5.22	4.81	6.5-8.5	6.5	8.5
EC(u/cm)	36-50	44	500	250	1480
TDS(mg/l)	0.02-0.05	0.03	500	500	1000
TH(mg/l)	12.8-16.2	14.0	-	100	500
Ca^{2+}	2- 12	6.0	-	75	200
Mg^{2+}	126-160	138	0.20	50	150
Na^{2+}	460- 864	648.6	200	-	-
K^{+}	3.8 7.4	6.0	15	-	200
Mn	0.01-0.03	0.02	-	-	-
Zn	0.01-0.05	0.03	-	-	-
Cl^{-}	22- 26	23.6	-	250	600
HCO_3^{-}	8-26	13.3	-	Variable	Variable
SO_4^{2-}	0.05 -0.56	0.31	100	250	500
NO_3^{-}	2.07- 10.49	-	50	-	50
PO_4	0.02-0.074				
Fe^{2+}	Not Detected	Not detected	-	-	1.0

Table 4: Parameters as regards Irrigation purposes from water samples in Alapoti area

Location source	TDS	EC	SSP	SAR	MAR	KR	PI	RSBC
HDW_1	20	45	13.07	39.30	39.30	10.94	2.09	6
HDW_2	22	47	54.64	2.18	30.21	2.31	17.28	8
HDW_3	22	49	15.25	3.29	8.78	1.17	3.29	4
HDW_4	24	50	16.81	6.01	63.00	4.83	8.19	10
BH_5	16	36	13.83	1.70	38.81	9.61	1.39	2
HDW_6	16	37	14.00	13.59	38.81	8.79	3.64	14

Table 5: Limits of some parameter indices for rating ground water quality and its sustainability in irrigation (after Ayers and Westcot, 1985, Easton, 1950 and Willcox, 1950)

Category	EC (µmhos/cm)	RSC (meg/L)	SAR	SSP (%)	Sustainability for Irrigation
i.	<117.509	<1.25	<10	<20	Excellent
ii.	11.507-508.61	1.25 – 2.5	10-18	20-40	Good
iii.	>503.62	> 2.5	18-26	40-80	Fair
iv.	-	-	>26	>80	Poor

Table 6: Range of Total Dissolved Solids for Irrigation Use (After Robinove *et al.,* 1958)

Classification	Total Dissolved Solids(mg/l)	Remarks
Non-Saline	< 1000	All samples in the study area fall in this zone
Slightly Saline	1000-3000	Nil
Moderately Saline	3000-10,000	Nil
Very Saline	>10,000	Nil

DISCUSSION

The pH values range from 4.28-5.22 which indicate slightly acidic water. A comparison with W.H.O and S.O.N standards for drinking water points out that the groundwater in the study area is contaminated. pH is a quantitative measure of the acidity or basicity of aqueous or other liquid solutions. It indicates whether water is likely to be either corrosive or scale forming. According to USEPA. (1985) standard, the pH value of acceptable water must be 7.0-8.5, while according to W.H.O. (2006) standards and S.O.N. (2007) standards, any water below 6.5 and higher than 8.0 are considered to be detrimental. Total Dissolved Solids is a measure of the combined content of all inorganic and organic substances contained in a liquid in molecular, ionized or micro-granular suspended form. The minimum and maximum permissible limited as stated by W.H.O. (2008) and S.O.N. (2007) is between 600-1000(mg/l) and 500(mg/l) respectively. The TDS range of the water samples is between 300-500 mg/l. it therefore does not fall within the W.H.O and S.O.N standards. Electrical conductivity ranges from 36-50µS/cm, with a mean of 44µS/cm which is not within W.H.O. (2008) and S.O.N. (2007) standards. Hence the high concentration of electrolytes poses health risks to humans; hence, the range is not tolerable.

The temperature of ground water remains relatively constant throughout the year. The ground temperature for an area is approximately equal to an area's annual average air temperature. The earth and ground water temperatures are much more stable than the highly variable seasonal air temperature. This stable and relatively constant source temperature makes the sizing procedure somewhat different than with earth- coupled piping loops. The temperature of the analyzed ground water from the study area Alapoti has a mean ranging value of 33.1°C to 33.8°C. Its abundance is dependent upon the type of rock through which the water passes. It is naturally high in water from chalk and limestone areas. It is usually present as calcium carbonate or bicarbonate and sulphate. However, in water of high salinity, calcium (Kilanko, 1995), chloride and nitrate can be found. Calcium is essential part of human diet but the nutritional value from water is likely to be minimal compared to the intake from food sources (Fawell, 1991). The concentration of calcium ion must not exceed 200ppm in ground water (Bower, 1978). The value of calcium below 10 is considered low while the value above 18 is relatively low (Johnson,1975). While the W.H.O recommended 200mg/l for the ground water samples, calcium is generally very high, ranges from 2-12mg/l and has a mean value of 6mg/l the values are lower than the recommended amount that should be contained in water.

The concentration of Magnesium in Alapoti area ranged from 126-160mg/l with a mean value of 138mg/l. This is considered high compared to the W.H.O standard. Excessive concentrations of magnesium are undesirable in domestic water because of problem of scale formation and also because of its diuretic effects. The W.H.O, 1993) guidelines and USEPA regulations (1992) do set a limit to magnesium level of water, but the (EC, 1980) and UK regulation (1989) gives the maximum allowance as 50mg/l. Sodium concentration is also high with average concentration of 648.6mg/l and ranging from 864-466mg/l.Sodium unlike calcium, magnesium and silica are not found as essential constituents of many of the common rock forming minerals. Sodium does not appear in large quality in ground water except ocean intrudes into aquifer (Trembly et al 1973). Potassium centration in ranged from 3.8-7.5 (mg/l) with mean value of 6(mg/l).

Chloride is the most prevalent anion in most water. It can be either as an anion(Cl^-) or in combination with some element such as NaCl, $CaCl_2$and $MgCl_{2.}$ (Twort et al, 1994). They are among the most suitable component in water. Chloride may be derived from seawater intrusion, air born sea spray from sewage, natural deposits and from industrial effluents. A high chloride content makes water salty to taste and unpleasant to use. Low concentration of this parameter is an indicative of absence of salt water contamination in ground water. Chloride contents greater than 40mg/l in coastal aquifer indicate salt water contamination (Trembly *et al*, 1973). The mean value of chlorine at Alapoti area is 23.6 and it ranges from 22 to 26. While the bicarbonate concentration of all the samples range from 8-26 with the men value of 13.3 mg/l. These values are far lower than the WHO standard.

Assessment of Alapoti groundwater for irrigation purposes.

The Sodium Adsorption Ratio (SAR) in the study area is low. The SAR is less than 10% in more than three quarter of the entire area. This makes the water to be excellent for irrigation. The sodium adsorption ratio gives a clear idea about the adsorption of sodium by soil. It is the proportion of sodium to calcium and magnesium which affects the availability of water to crop. The magnesium content of water is one of the most important qualitative criteria in determining the quality of water for irrigation. More magnesium in water will adversely affect crop yields as the soil becomes more saline (Joshi *et al.,* 2009). The magnesium adsorption ratio calculates for water in Alapoti area ranged between 8.78 and 38.81 and this is very adequate for irrigation. Soluble sodium percentage is an important factor for studying sodium hazard and for adjudging the quality of water for agricultural purposes. According to (Joshi *et al.,* 2009), high percentage sodium in water for irrigation purpose may stunt the plant growth and also reduces soil permeability. The values of SSP in this area vary from 13.07% to 16.81%. The values are within the acceptable limit of 50%. The waters are therefore considered to be suitable for irrigation. The permeability index values range from 2.09% to 17.28% and these can be categorized as good irrigation water (Doneen, 1964). The Kelly Ratio values are generally low indicating good water for irrigation.

CONCLUSION

Geo- physical imaging has been effective in delineation of groundwater potential in Alapoti, South-western Nigeria. 2-D imaging was able to map and delineate the water potential zones in which five traverses were covered. The resistivity survey yielded three major geologic units these are: Fresh water/Aquifers/Surface water. Geophysical imaging identified 5, 6,4,4,5 different soil horizons in Traverse 1, 2,3,4,5 respectively. The five layers in traverse one is made up of: sand and laterite, very fresh water, wet sand, lateritic clay, lateritic sand respectively. The six layers in traverse two is made up of surface water, wet sand, lateritic sand, sandstone, very dry sand stone, Porous Limestone respectively. The four layers in traverse three is made up of: shallow aquifer, laterite and lateritic sand respectively. The Four layers in traverse four is made up of top soil, fresh water, lateritic sand, lateritic clay respectively. The five layers in traverse five is made up of: Surface water/ clay, Lateritic in nature, Lateritic sand, Wet sandstone, Sandstone respectively. Traverses 1, 2, and 4 contain fresh water that can be accessed with construction of borehole because of the depth of occurrence. Traverses 3 and 5can only provide Surface water via hand dugs which are liable to contamination at the depth of about3m. The water at Alapoti is partially potable though slightly acidic and the Sodium content is within the recommended W.H.O and S.O.N Standard values. All other chemical compositions are generally below the W.H.O and S.O.N recommendations. In addition to the portability of Alapoti waters, the generally low ratios of sodium adsorption, magnesium adsorption and soluble sodium percentage with other irrigation indices make the groundwater in Alapoti to be good for irrigation purposes.

Acknowledgements.

The authors wish to acknowledge Prof. Philip Aizebeokhia of Covenant University, Ota, Ogun State for his field assistance during the geophysical survey.

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