CHARACTERIZATION OF THE COASTAL SALTWATER INTRUSION IN BADAGRY, LAGOS, SOUTH –WESTERN NIGERIA, USING GEOELECTRICAL SURVEY

ABSTRACT

A geophysical technique was employed to investigate seawater intrusion into freshwater aquifers in the coastal environment of the Lagos, Badagry, and South-Western Nigeria. Electrical resistivity method employing the Schlumberger technique was used to acquire data for eighteen vertical electrical soundings, and five 2-D electrical resistivity profiling using the Wenner array to investigate the vertical extent of seawater intrusion. The Wenner electrode array, which utilizes current electrode half spacing from 1m to 600m, was used to acquire resistivity data in the proximity of the lagoon. Curve types such as the KQ, KQQ, and HKQ were generated for the investigated area also; 4-5 geoelectric layers were generated to a maximum depth of 68m. The subsurface lithology comprise of fine through medium grained sand to coarse sand intercalated in most cases with sandy clay and clayey sand. The resistivity of the intruded saline water was found to range between 7-32Ωm at a depth interval of 9.2 – 54.5m and the thickness of saline layers was found to be greater in areas close to the coast. This study shows that both the 2D electrical resistivity imaging and wenner sounding resistivity methods are efficient tools for investigating the saltwater-freshwater interface in coastal areas. Detailed survey should be carried out before citing boreholes due to variation in depth to deeper fresh aquifers. It is recommended that down-the-hole geophysical loggings should be carried out after drilling so that the screen can be installed at appropriate non-saline zone.

Keywords: Geoelectric sections, resistivity, seawater intrusion.

Introduction

In many developed and developing countries there is not only a heavy reliance on ground water as a source of drinking water but also as a supply of water for both agricultural and industrial use. Geophysics, especially Geoelectric techniques have been successfully used to detect the fresh/salt-water interface in coastal aquifers e.g. (Barker, 1980). These methods include the DC resistivity method (Yang, et al. 1999) and transient electromagnetic induction (TEM) method (Stewart and Gay, 1986). Resistivity surveys are often used to search for ground water in both porous and fissured media. This method provides detailed information about the geometry, source and concentration of contamination in the groundwater (Kelly, 1976). In areas where the ground water is significantly saline, the resistivity is reduced considerably and resistivity method can delineate the boundaries of fresh-salt water. Griffith and Barker (1993) present the results of strong resistivity contrast, which can occur across the junction between fresh and saline water using the resistivity survey. Additionally, large differences between the resistivity of saltwater and freshwater saturated zones have been used by many investigators for determination of saltwater intrusion in many coastal areas (e.g. Frohlich et al., 1994). This work aims to study the subsurface soil layers and delineate the ground water aquifer in the Badagry area, as well as delineate the sections of seawater intrusion in the fresh water aquifer zones.

Adepelumi *et al.* (2008) in an attempt to demarcate possible areas for groundwater development in the Lekki area of Lagos state, obtained resistivity results which revealed a dominant trend of decreasing resistivity with depth, indicating an increase in salinity with depth. He however traced the presence of the salinity to excessive groundwater pumping and the reduction of groundwater gradients.

Furthermore he established the inherent presence of saline water in the subsurface of Lekki area as being trapped during the transgressive and the regressive movement of the ancient sea during the quaternary times when some sediment were contemporaneously deposited under marine condition. He inferred that the saline water found at a shallow depth (10-30 m) was probably trapped during marine transgression and/or it migrated from depth by differential pressure-gradient. One can infer the source of saline water in the subsurface as connate according to the referenced report. However, he did not mention the influence of the lagoon which surrounds the study area. Their analysis is based on Kingston *et al* (1983) who suggested that prior to the fluctuation of the sea level in Lagos area, series of miogeoclinal depressions were formed at the edge of the rifting Atlantic Ocean. These depression zones were later filled with seawater where the sediments were deposited. It can be inferred that the saltwater was trapped during the period of marine deposition. The possibility of seawater intrusion by the tidal movement of saline seawater presently was not examined which this study attempts to bridge.

DESCRIPTION OF STUDY AREA : The Badagry Creek (Fig. 1), which is approximately 60 km long and 3 km wide, lies between longitudes 3°0′ to 3°45′ E and between latitudes 6°25′ to 6°30′ N. It falls within the Eastern Dahomey basin of Nigeria. Geology of the basin has been variously studied and reported by many authors such as Jones and Hockey (1964), Adegoke (1977), Omatshola and Adegoke (1981), Agagu (1985) and Nton (2001). These studies deduced that the exposed lithologic units of Lagos is made up of coastal plain sand (otherwise called Benin formation (Jones & Hockey, 1964)) and Recent littoral alluvial deposits. The Coastal plain sand

consists of thick yellowish ferruginised and white sands (Jones & Hockey, 1964). It is poorly sorted, composed of loosed sediments ranging from silt, clay and fine to coarse grained sand with intercalation of shale, clay lenses and sandy clay with lignite. The sands are in part cross bedded and show transitional to continental characteristics according to Jones and Hockey (1964), Omatshola and Adegoke (1981), Agagu (1985), Enu (1990) and Nton (2001). It is part of a continuous system of lagoons and creeks along the coast of Nigeria from the border with the Republic of Benin to the Niger delta. Its water depth ranges from 1 m to 3m. The lagoon experiences two broad seasons: the dry season (December - May) and the wet season (June - November). Most of the year is characterized by fresh and slightly brackish water.

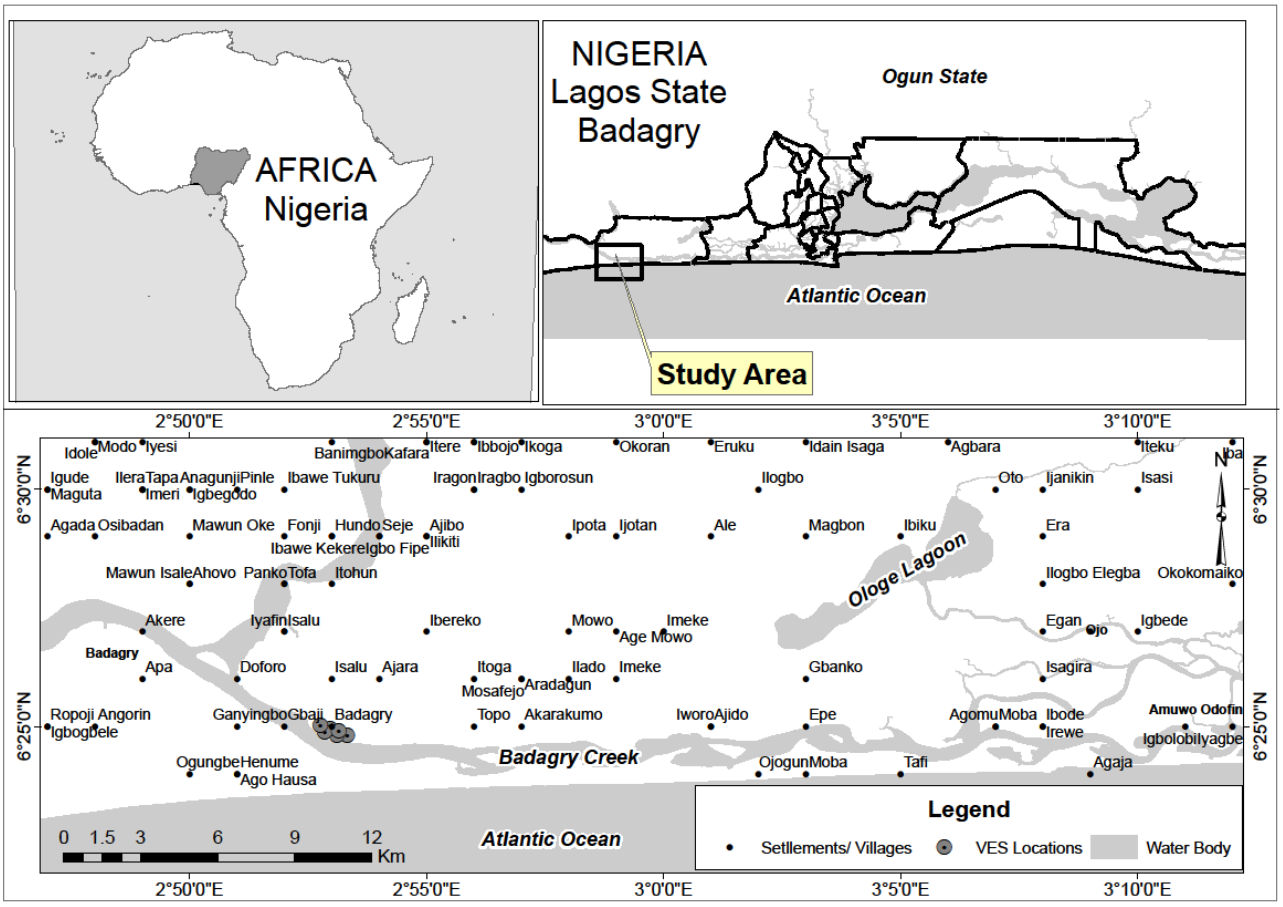


Figure 1: Map showing the study area

The lagoon is approximately equidistant from the entrances of Lagos and Cotonou harbors. As a result, it is influenced by tides and floods from the Lagos Lagoon and Cotonou harbour through Lake Nokue and Lake Porto-Novo (Anyanwu & Ezenwa, 1988). The Yewa River with its tributaries Isalu and Ijomo is the major river emptying into the lagoon. Creeks connected to the lagoon include Bawa and Doforo.

DATA ACQUISITION AND PROCESSING

The geophysical survey was aimed to acquire information on the hydrogeology of the area in order to predict the thickness of the aquifer and the depth to freshwater-saltwater interface. An ABEM SAS 4000 Terrameter was used for the electrical resistivity survey, whereby consecutive readings are taken automatically and the result averaged continuously. In this work, a total of eighteen VES points were covered along selected traverses 1 to 5 (Profile 1 to 5 in Fig 3). Due to limited perpendicular space to the shoreline all the traverses were taken parallel to the shoreline but Traverses 2 and 4 were taken landward. The Schlumberger electrode array was utilized for the data acquisition which was done with the ABEM terrameter SAS 1000. It works under the principles of the wider the current electrodes, the deeper the current penetration. The Vertical Electrical Sounding was carried out and the total electrode spread was 600m, (AB/2 = 300m). The field data obtained was interpreted using WinResist and WinGLink Computer softwares and the results were correlated with the manual curve matching method of interpretation of the apparent resistivity values. 2-D electrical resistivity using the wenner array was also employed in acquiring the geophysical data. The wenner configuration was used for the sounding in accordance with Parasnis (1979) and Zohdy (1974). Forward modelling and Inversin was carried out on the data using RES2D software and the result is presented as colour coded section of 2D Resistivity Tomograms in order to observe the resistivity, thickness, and depth of subsurface layers laterally and vertically.

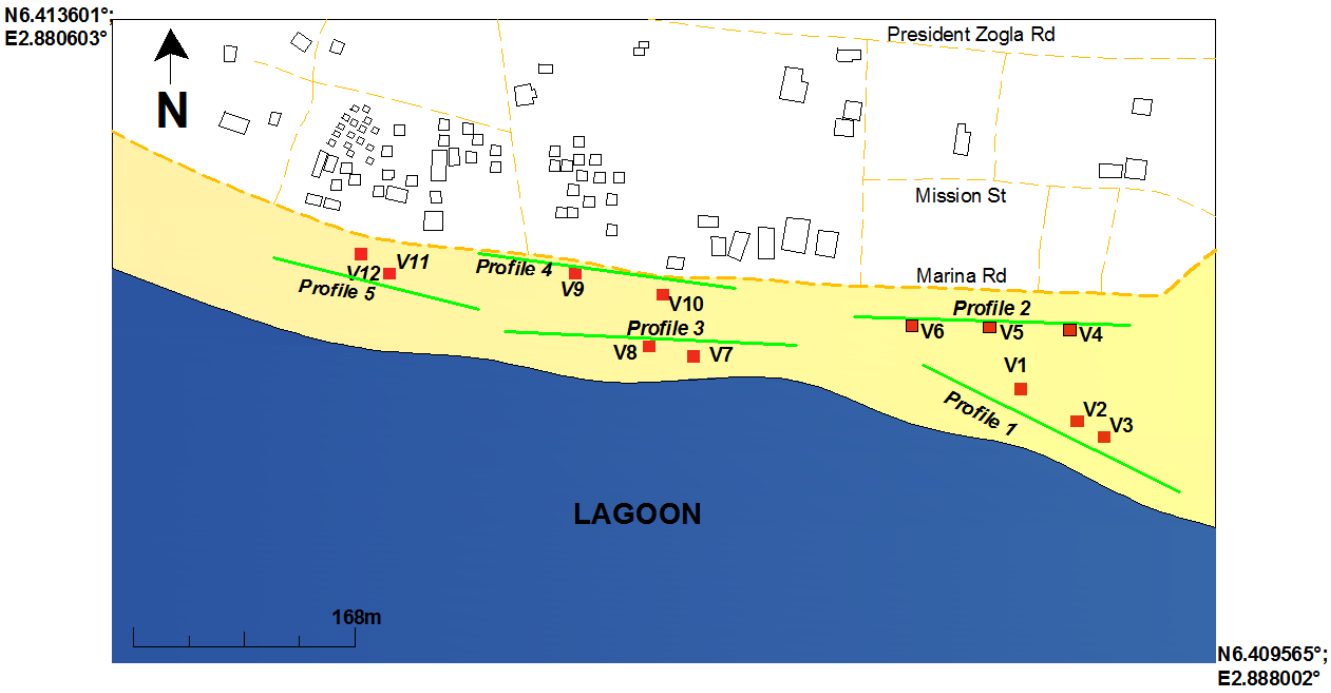


Fig. 3 Base map of the study area showing the VES stations and 2D Profiles

RESULTS AND INTERPRETATIONS

RESULT

The results of the iterated Vertical Electrical Sounding data are presented in Appendix 1. Table 1 consists of the summary of the interpreted resistivity, inferred lithology and its implication as regards this study. The result of profiling method is presented as 2D Electrical Resistivity Tomography and integrated with the result from the VES in order to provide a detailed interpretation on each of the traverse.

Table 1. Resistivity, thickness, depth, lithology and remarks of soil layers on each station

Profile	Station	Layer	Resistivity (Ωm)	Thickness (m)	Depth (m)	Lithology	Remarks
Profile 1	VES 1	1	630	1.1	1.1	Topsoil	Sand filled
		2	521	0.12	1.22	Sand	
		3	61	15.76	16.98	Sand	Fresh/Brackis
		4	31	-	-	Sand	Saline
	VES 2	1	691	1.39	1.39	Topsoil	
		2	146	0.78	2.17	Sand	
		3	67	24.19	26.36	Sand	Fresh/Brackis
		4	27	-	-	Sand	Saline
	VES 3	1	666	1.47	1.47	Topsoil	Sand filled
		2	44	5.04	6.51	Clayey Sand	
		3	76	14.06	20.57	Sand	Shallow FW
		4	24			Sand	Saline
Profile 2	VES 4	1	1243	1.48	1.48	Topsoil	Sand filled
		2	404	0.98	2.46	Sand	
		3	98	7.01	9.47	Sand	Fresh
		4	48	22.07	31.54	Sand	Brackish
		5	19			Sand	Saline
	VES 5	1	1169	0.34	0.34	Topsoil	Sand filled
		2	2662	0.89	1.23	Sand	
		3	49	5.89	7.12	Clayey Sand	
		4	131	39.91	47.03	Sand	Shallow FW
		5	38			Sand	Saline
	VES 6	1	1452	1.51	1.51	Topsoil	
		2	618	0.66	2.17	Sand	
		3	38	5.16	7.33	Clayey Sand	
		4	177	14.37	21.7	Sand	
		5	51			Sand	
Pro file	VES 7	1	610	0.92	0.92	Topsoil	
		2	252	0.38	1.3	Sand	

		3	70	4.96	6.26	Sand	
		4	15	27.28	33.54	Sand	
		5	2			Sand	
	VES 8	1	795	1.23	1.23	Topsoil	
		2	238	0.82	2.05	Sand	
		3	58	8.49	10.54	Sand	
		4	29	45.58	56.12	Sand	
		5	17			Sand	
Profile 4	VES 9	1	152	0.57	0.57	Topsoil	
		2	41	1.1	1.67	Clayey Sand	
		3	32	0.68	2.35	Clayey Sand	
		4	183	12.96	15.31	Sand	
		5	30.56			Sand	
	VES 10	1	1628	0.73	0.73	Topsoil	
		2	1322	0.19	0.92	Sand	
		3	49	16.05	16.97	Sand	
		4	20			Sand	
Profile 5	VES 11	1	38	0.98	0.98	Topsoil	
		2	23	5.15	6.13	Clayey Sand	
		3	69	11.64	17.77	Sand	
		4	13			Sand	
	VES 12	1	58	1.32	1.32	Topsoil	
		2	10	2.64	3.96	Clayey Sand	
		3	21	1.13	5.09	Clayey Sand	
		4	84	14.44	19.53	Sand	
		5	2			Sand	

INTERPRETATIONS OF VERTICAL ELECTRICAL SOUNDING AND 2D ELECTRICAL RESISTIVITY TOMOGRAMS ALONG EACH TRAVERSE

The 2D resistivity results obtained by the inversion algorithm performed with the software RES2DINV are shown as images in Appendix 1. Electrical resistivity values are related to geological parameters of the subsurface and, in particular, resistivity values are controlled by the types of rocks and fluid. Then, the high-resolution electrical images are powerful tool to identify conductive zones for the saltwater intrusion phenomena. Appendix 2 shows the 2D electrical images obtained in the study area related which reveals the depth and the true resistivity of the subsoil investigated. The analysis of resistivity data reveals the presence of four and in some cases five geoelectric layers. Typical curve types characteristic of saline water intruded zones were observed such as AKQ, KQH, KQ and KQQ. The descending segment of the VES curves is characterized by a steeply low resistivity zone. Lithology has been ascribed based on the resistivity distribution of each layer and the result of the borehole investigation of the existing wells surrounding the study area. The summary of the interpretation is detailed in Table 1.0 and Figure 9.

TRAVERSE 1

The geo-electrical section of the four VES (VES 1 to 4) is presented in Fig 4a and the 2D Electrical Resistivity Tomogram is presented in Fig 4b.

The topsoil is with electrical resistivity range of 239 to 1429Ωm and thickness range of 0.2 to 1.38m. The high resistivity of this layer can be associated to the recent sand filling at the time of investigation. The second geoelectric layer is Sand/Clayey Sand with a thickness of 15 to 24.7m and electrical resistivity range of 40 to 67Ωm indicative of intermediate/brackish water. The third geoelectric layer is Sand/Clay

within the depth range of 37 to 55m and low electrical resistivity range of 15 to 26Ωm indicative of saltwater impacted aquifer due to the proximal lagoon. The third layer may also compose of Clay layer and might have been difficult to delineate from the saltwater zones due to their similar resistivity signature. The second layer represents the shallow aquifer from which hand dug wells are sourced and are with low quality to brackish aquifer that straddle over the saltwater aquifer of the third layer. Continuous extraction of the shallow intermediate quality aquifer may lead to further increase in the level of the saltwater zone. The fourth layer is composed of Sand with resistivity range of 108 to 694Ωm with undetermined depth.

The 2D Electrical Resistivity Tomogram have shown a similar result and have clearly shown both the vertical and lateral variation of resistivity distribution in the subsurface. The saltwater interface between the shallow aquifer and saltwater intruded zone is between 13 to 21m. The 2D ERT section terminates at a depth of 33m and have only been able to delineate the saltwater intruded region.

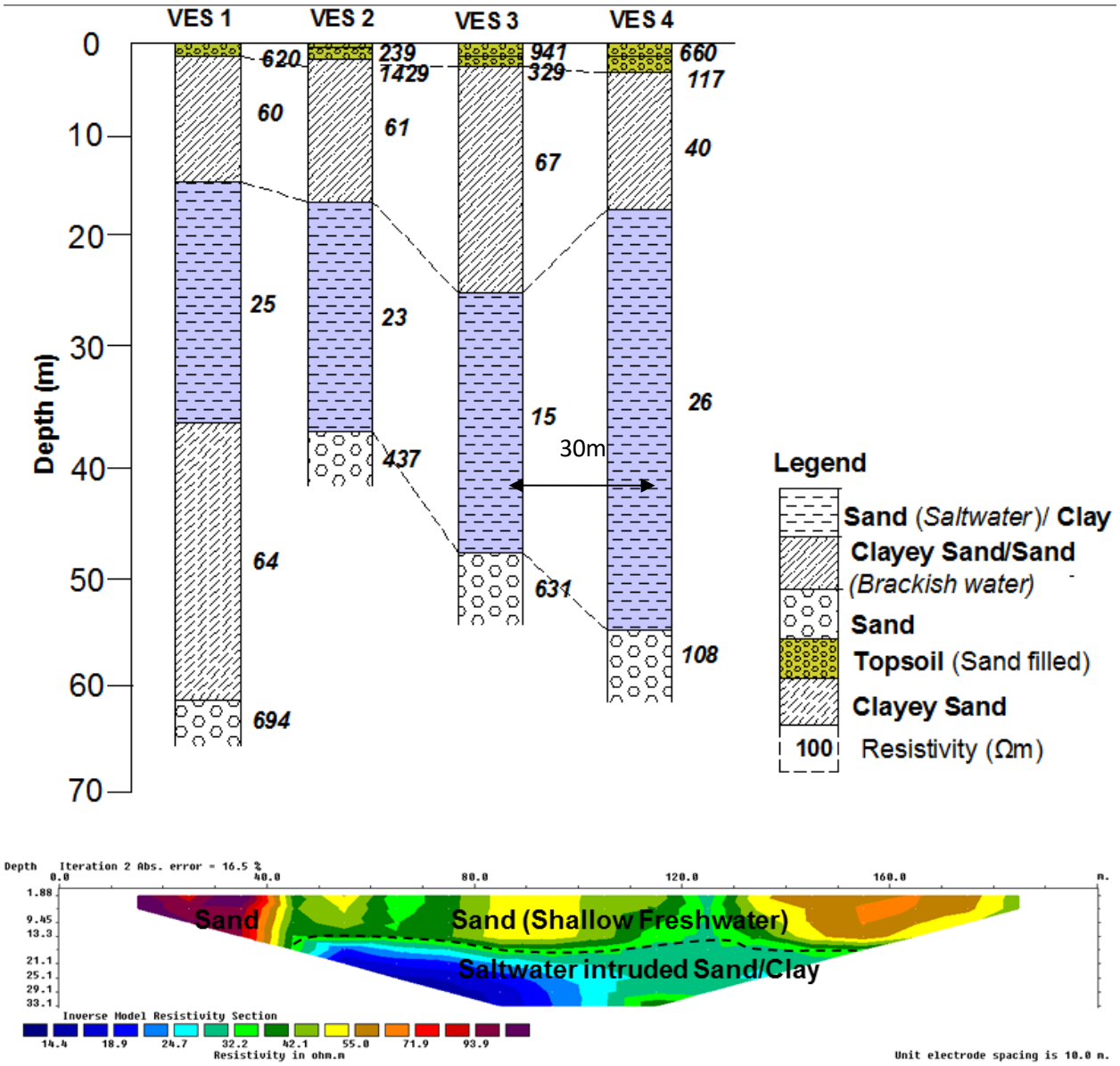


Fig. 4a and 4b. Geoelectric section and 2D ERT of soil layers on Traverse 1

TRAVERSE 2

The geo-electrical section of the four VES is presented in Fig 5a and the 2D Electrical Resistivity Tomogram is presented in Fig 5b. Lithology have been ascribed based on

the resistivity distribution of each layer, the summary of the interpretation is detailed in Table 1.0.

The topsoil is with electrical resistivity range of 686 to 2126Ωm and thickness range of 1.67 to 1.98m. The high resistivity of this layer can be associated to the recent sand filling at the time of investigation. The second geoelectric layer has a thickness of 16.2 to 32.7m composed of Sand/Clayey-Sand with electrical resistivity range of 65 to 83Ωm indicative of fresh to brackish water. The third geoelectric layer has a thickness of 49.7 to 57.8m composed of Sand impacted by saltwater or Clay with low electrical resistivity range of 15 to 21Ωm indicative of saltwater impacted aquifer due to the proximal lagoon. The third layer may also compose of Clay layer and might have been difficult to delineate from the saltwater zones due to their similar resistivity signature. The second layer represents the shallow aquifer from which hand dug wells are sourced and are with low quality to brackish aquifer that straddle over the saltwater aquifer of the third layer. Continuous extraction of the shallow intermediate quality aquifer may lead to further increase in the level of the saltwater zone. The fourth layer is composed of Sand with resistivity range of 152 to 375Ωm with undetermined depth and represents region of freshwater at the time of investigation.

The 2D Electrical Resistivity Tomogram have shown a similar result and have clearly shown both the vertical and lateral variation of resistivity distribution in the subsurface. The saltwater interface between the shallow aquifer and saltwater intruded zone is between 13 to 20m. The 2D ERT section terminates at a depth of 33m and have only been able to delineate the saltwater intruded region.

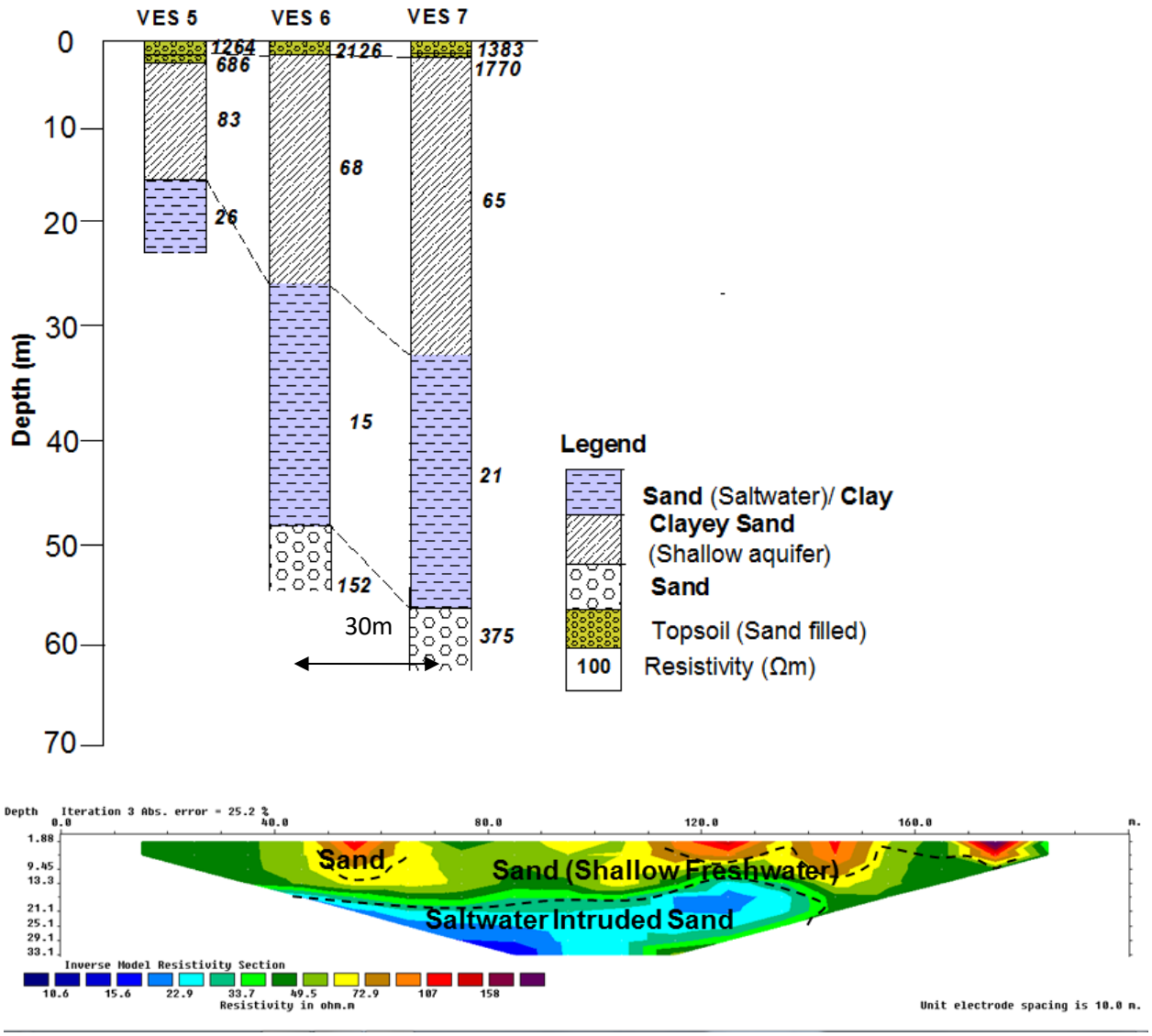


Fig. 5a and 5b. Geoelectric section and 2D ERT of soil layers on Traverse 2

TRAVERSE 3

The geo-electrical section of the along Traverse 3 (VES 8 to 10) is presented in Fig 6a and the 2D Electrical Resistivity Tomogram is presented in Fig 6b.

The topsoil is with electrical resistivity range of 388 to 825Ωm and thickness range of 1.2 to 2.1m. The high resistivity of this layer can be associated to the recent sand filling at the time of investigation. The second geoelectric layer is within the depth

range of 7 to 16.2m composed of Sand/Clayey-Sand with electrical resistivity range of 55 to 86Ωm indicative of fresh to brackish water. The third geoelectric layer is within the depth range of 23.5 to 38.4m composed of Sand impacted by saltwater or Clay with low electrical resistivity range of 5 to 15Ωm indicative of saltwater impacted aquifer due to the proximal lagoon. The third layer may also compose of Clay layer and might have been difficult to delineate from the saltwater zones due to their similar resistivity signature. The second layer represents the shallow aquifer from which hand dug wells are sourced and are with low quality to brackish aquifer that straddle over the saltwater aquifer of the third layer. Continuous extraction of the shallow intermediate quality aquifer may lead to further increase in the level of the saltwater zone. The fourth layer is composed of Sand with resistivity range of 111 to 431Ωm with undetermined depth and represents region of freshwater at the time of investigation.

The 2D Electrical Resistivity Tomogram has shown a similar result and have clearly shown both the vertical and lateral variation of resistivity distribution in the subsurface. The saltwater interface between the shallow aquifer and saltwater intruded zone is between 9.1 to 18m. The 2D ERT section terminates at a depth of 33m and have only been able to delineate the saltwater intruded region.

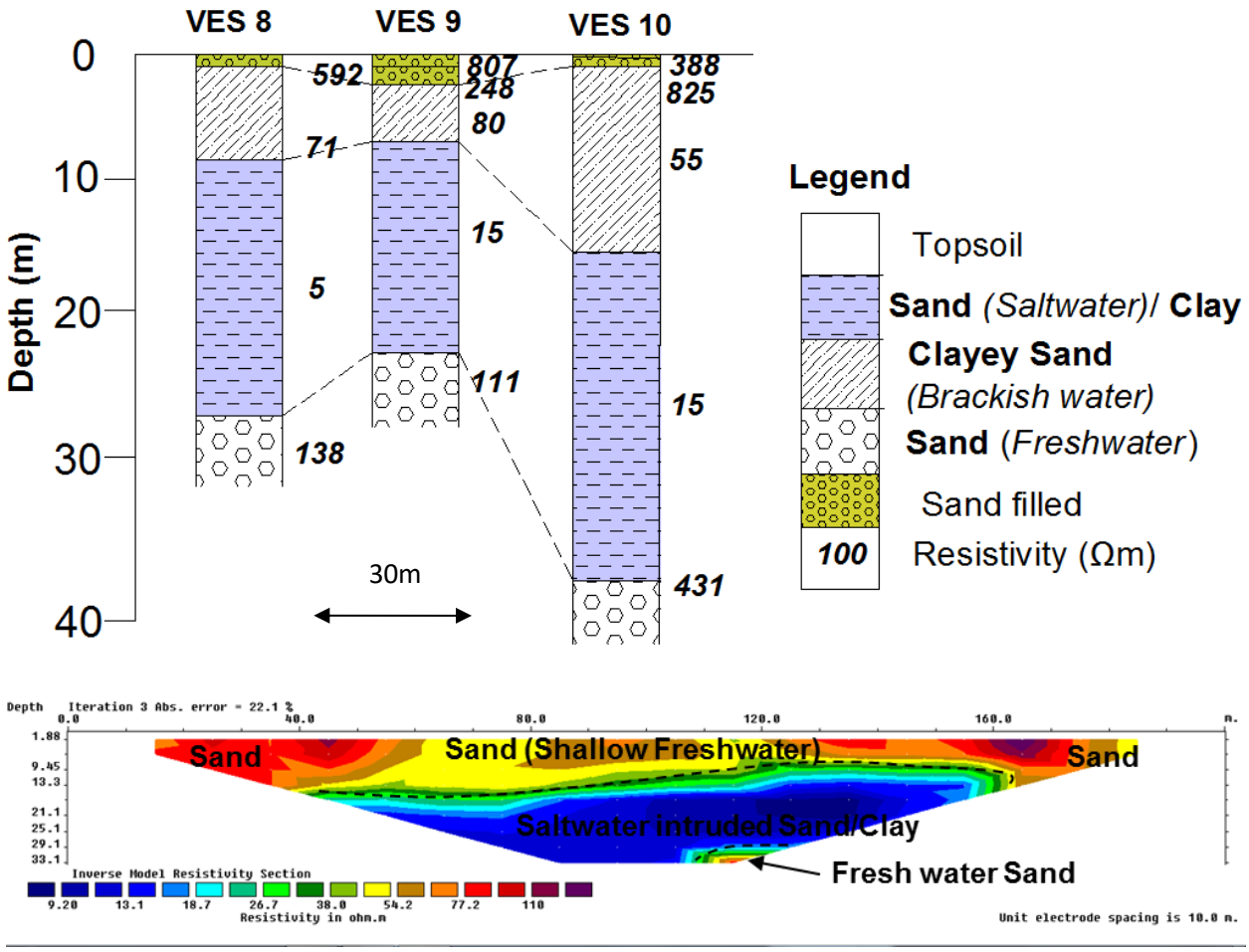


Fig. 6a and 6b. Geoelectric section and 2D ERT of soil layers on Traverse 3

TRAVERSE 4

The geo-electrical section of the along Traverse 4 (VES 16 to 18) is presented in Fig 7a and the 2D Electrical Resistivity Tomogram is presented in Fig 7b.

The topsoil is with electrical resistivity range of 41 to 684Ωm and thickness range of 1 to 1.75m. The second geoelectric layer is within the depth range of 13.2 to 19.8m composed of Sand/Clayey-Sand with electrical resistivity range of 24 to 123Ωm indicative of fresh to brackish water. The third geoelectric layer is within

the depth range of 33.2 to 36.4m with low electrical resistivity range of 7 to 14Ωm indicative of saltwater intrusion from the proximal lagoon/ocean into Sand aquifer or/and presence of Clay. The third layer may compose of saltwater impacted Sand and Clay layer and might have been difficult to delineate from the saltwater zones due to their similar resistivity signature. The Clay layer, if underlying the saltwater intruded zone may impede further intrusion into underlying aquifer. The second layer represents the shallow aquifer from which hand dug wells are sourced and are with low quality to brackish aquifer that straddle over the denser saltwater aquifer of the third layer. Continuous extraction of the shallow intermediate quality aquifer may lead to further increase in the level of the saltwater zone. The fourth layer is composed of Sand with resistivity range of 99 to 109Ωm with undetermined depth and represents region of freshwater at the time of investigation.

The 2D Electrical Resistivity Tomogram have shown a similar result and have clearly shown both the vertical and lateral variation of resistivity distribution in the subsurface. The saltwater interface between the shallow aquifer and saltwater intruded zone is between 10 to 14.2m. The 2D ERT section terminates at a depth of 33m and have only been able to delineate the saltwater intruded region.

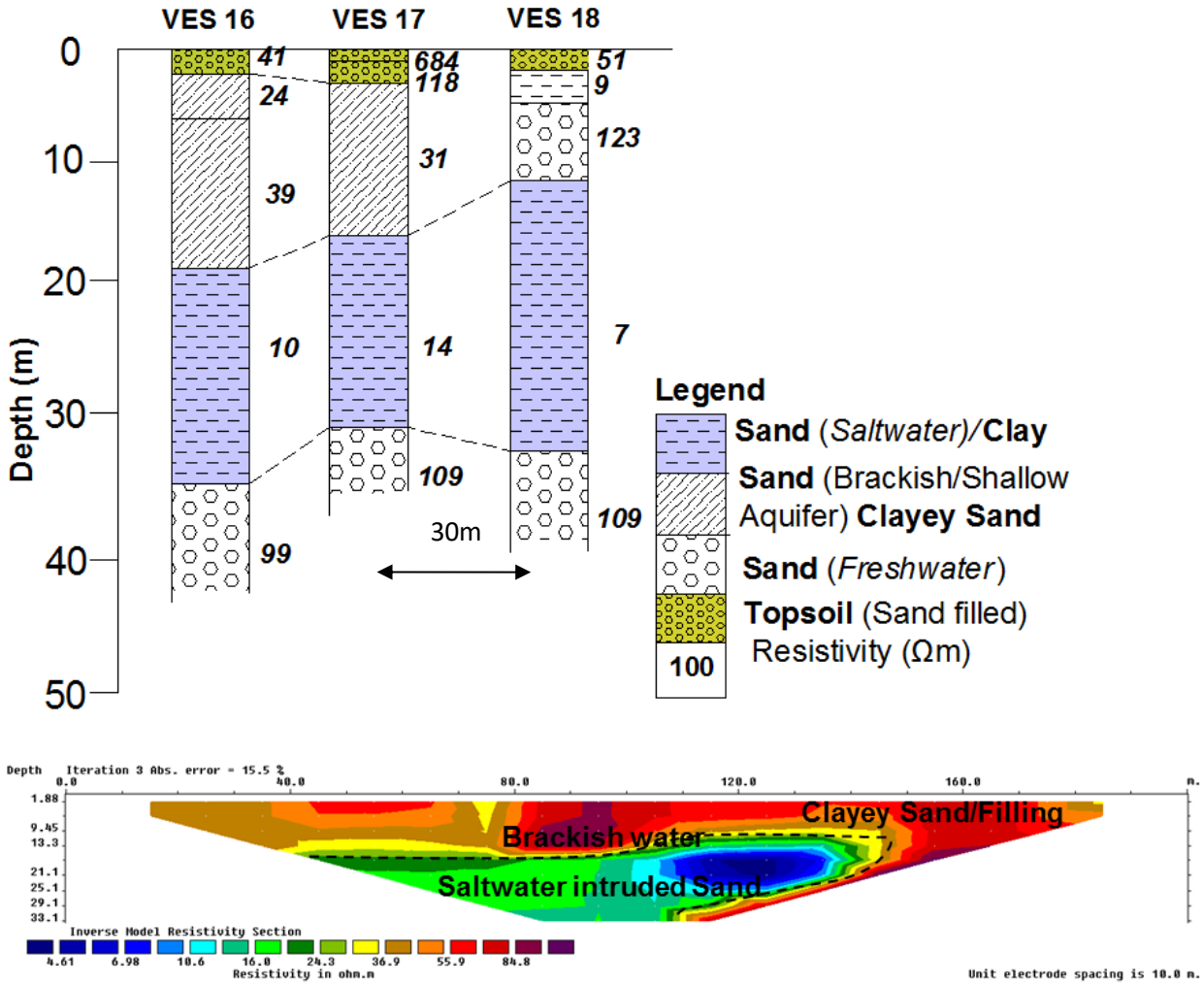


Fig. 7a and 7b. Geoelectric section and 2D ERT of soil layers on Traverse 4

TRAVERSE 5

The geo-electrical section of the along Traverse 5 (VES 11 to 15) is presented in Fig 8a and the 2D Electrical Resistivity Tomogram is presented in Fig 8b.

The topsoil is with electrical resistivity range of 157 to 1712Ωm and thickness range of 0.58 to 1.37m. The high resistivity of this layer can be associated to the recent sand filling at the time of investigation. The second geoelectric layer is within the depth range of 11.5 to 25.6m composed of Sand/Clayey-Sand with electrical resistivity range of 34 to 75Ωm indicative of fresh to brackish water. The third

geoelectric layer is within the depth range of 38.3 to 55.5m with low electrical resistivity range of 13 to 41Ωm indicative of saltwater intrusion from the proximal lagoon/ocean into Sand aquifer or/and presence of Clay. The third layer may compose of saltwater impacted Sand and Clay layer and might have been difficult to delineate from the saltwater zones due to their similar resistivity signature. The Clay layer, if underlying the saltwater intruded zone may impede further intrusion into underlying aquifer. The second layer represents the shallow aquifer from which hand dug wells are sourced and are with low quality to brackish aquifer that straddle over the denser saltwater aquifer of the third layer. Continuous extraction of the shallow intermediate quality aquifer may lead to further increase in the level of the saltwater zone. The fourth layer is composed of Sand with resistivity range of 125 to 453Ωm with undetermined depth and represents region of freshwater at the time of investigation.

The 2D Electrical Resistivity Tomogram have shown a similar result and have clearly shown both the vertical and lateral variation of resistivity distribution in the subsurface. The saltwater interface between the shallow aquifer and saltwater intruded zone is between 9.1 to 18m. The 2D ERT section terminates at a depth of 33m and have only been able to delineate the saltwater intruded region. A portion of the freshwater (148 to 293Ωm) underlying the saline water can be observed at a depth of about 31m and lateral distance of about 120m.

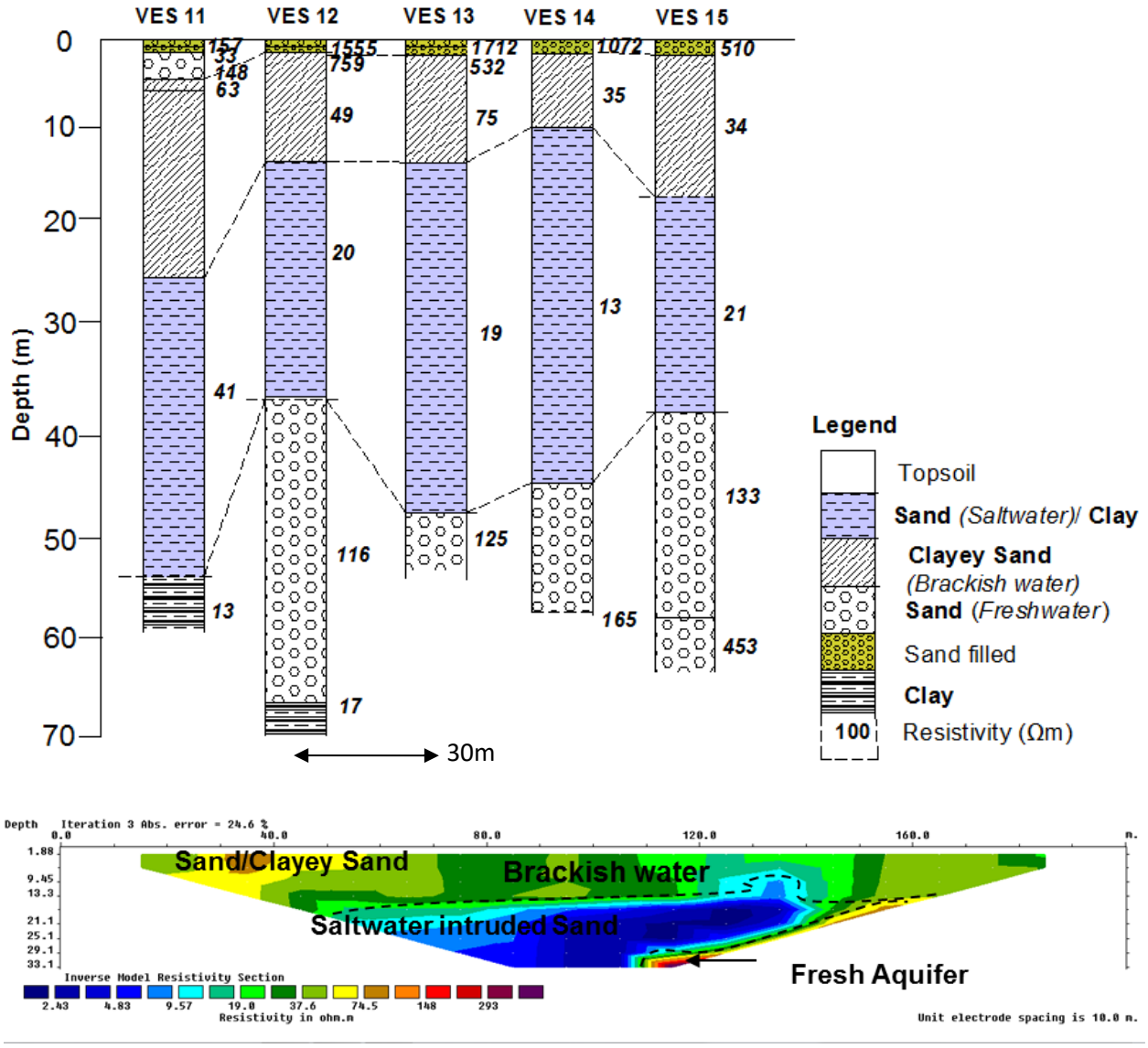


Fig.8a and 8b. Geoelectric section and 2D ERT of soil layers on Traverse 5

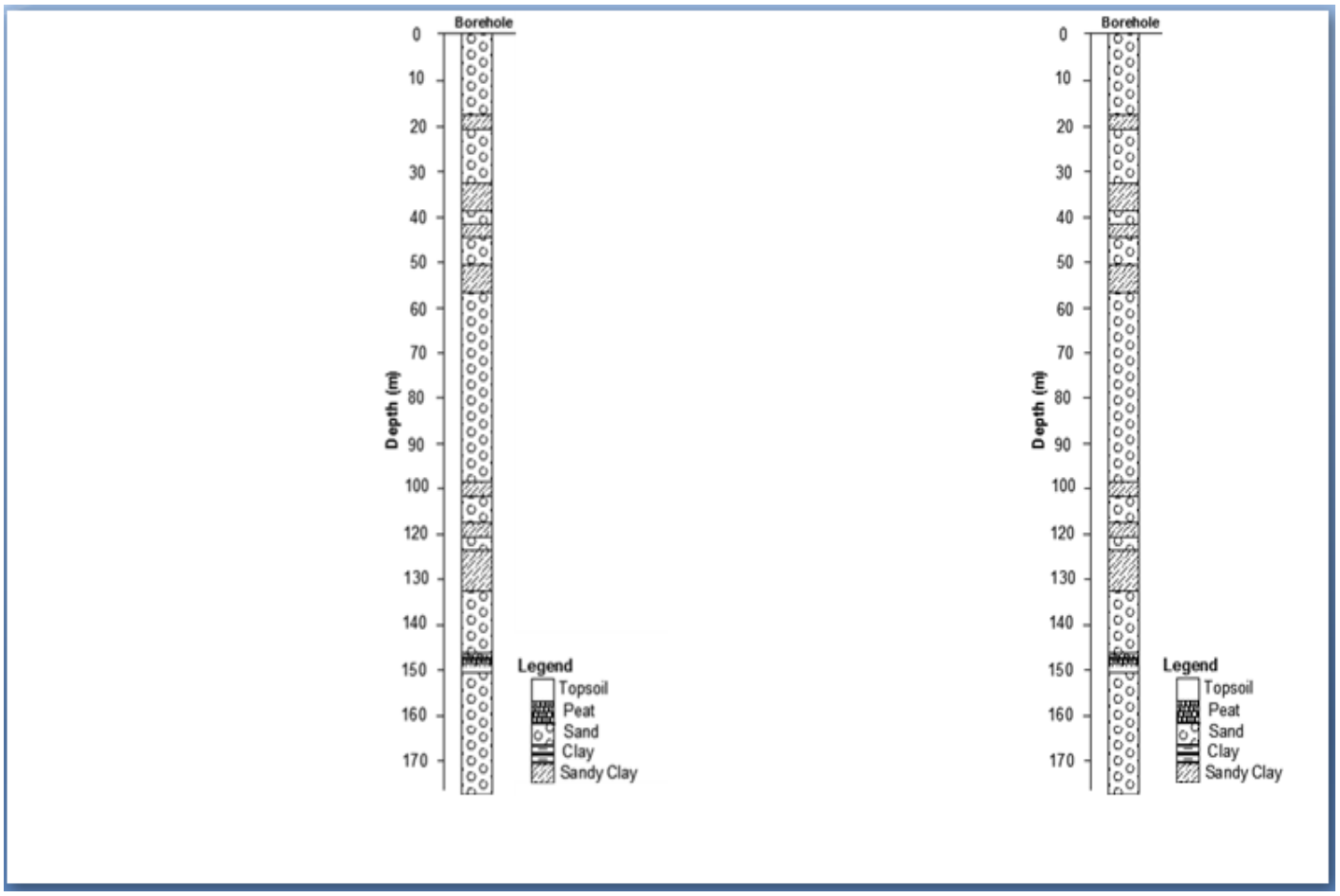


Fig. 9 Borehole lithology of the study area

CONCLUSION

1D and 2D electrical resistivity have been carried out at Badagry, South Western Nigeria and saltwater intrusion has been reported in the work. Interpretation of electrical resistivity tomography shows high pollution of the subsurface soils around the study area from a depth of about 8m up to a depth of 33m. This was further confirmed by VES where it indicates pollution to the depth above 55m. This depth falls within the third aquifer horizon where average inhabitants of the area exploit groundwater for domestic uses. Both ERT and VES also delineate sand horizon as the layer affected by the intrusion. The resistivity range of the

contaminated layer is below 40Ωm (1 to 32Ωm) as revealed by both VES and ERT. Contamination of subsurface soil in the study area accounts for a number of health-related challenges the inhabitants of the area are facing as a result of drinking saltwater. Any borehole or water well not deeper than 50m may not be free from saline water contamination, as revealed by both ERT and VES results. It is recommended that adequate geophysical survey be carried out in citing boreholes in the area due to variation in depth of saltwater intrusion.

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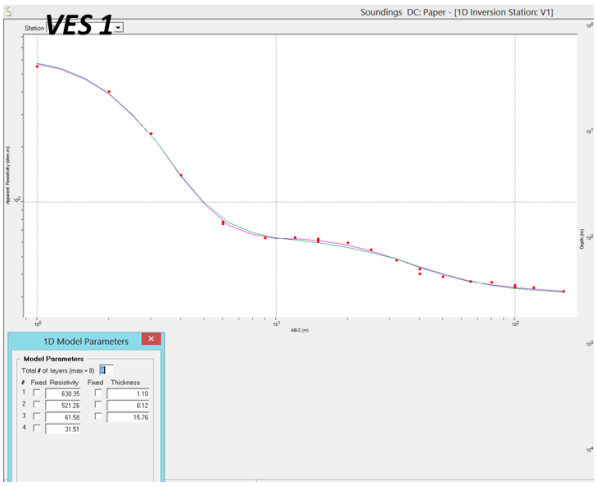
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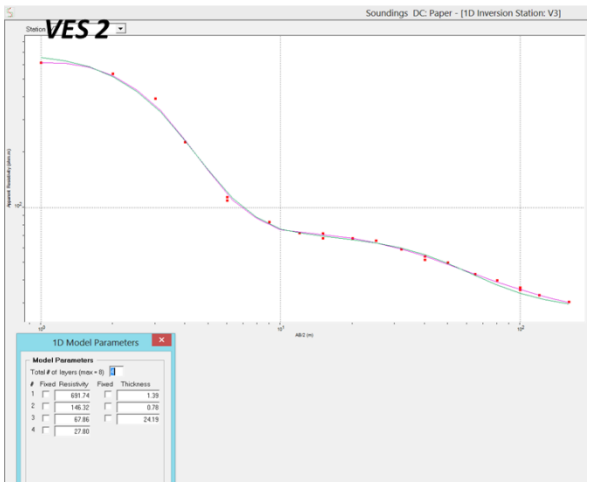
16 **Keller, G. V., & Frischknecht, F. C. (1966).** *Electrical Methods in geophysical prospecting*. Oxford: Pergamon Press Inc.

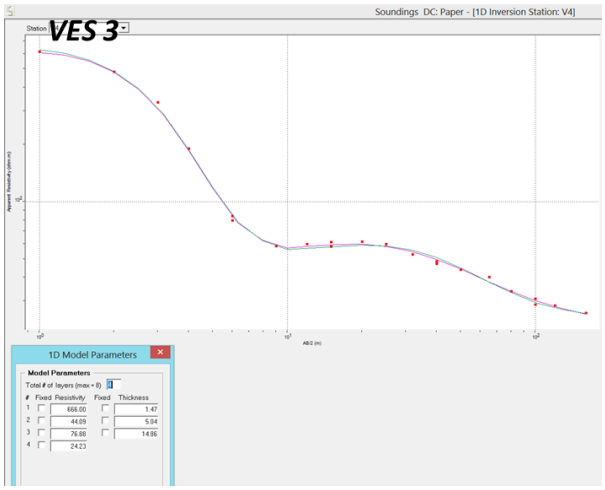
17 **Daniels, F., & Alberty, R. A. (1966).** *Physical Chemistry*. John Wiley and Sons, Inc

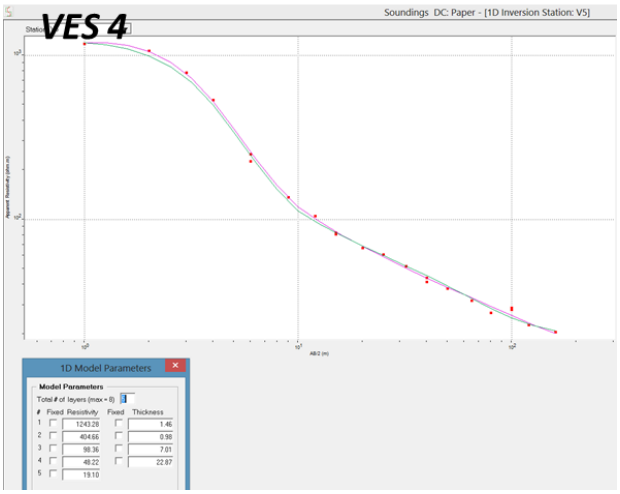
APPENDIXES

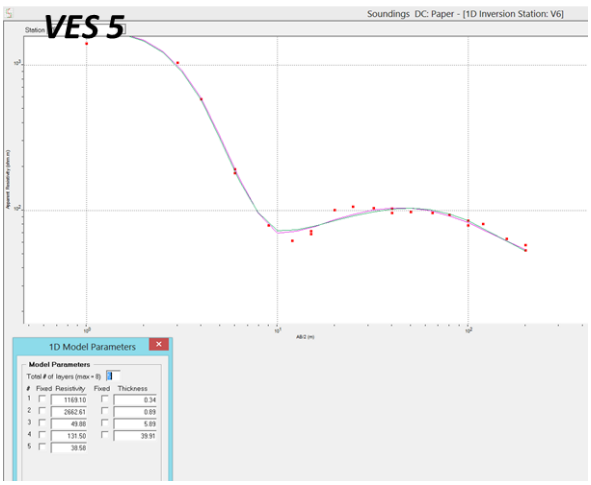
Appendix1: Computer Iterated Resistivity curves for VES 1-12

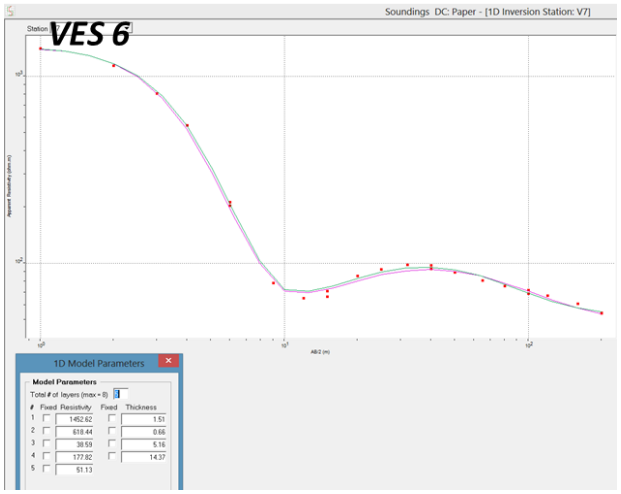


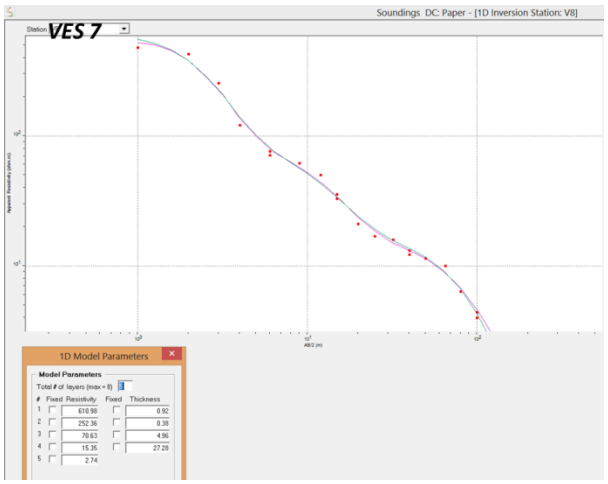


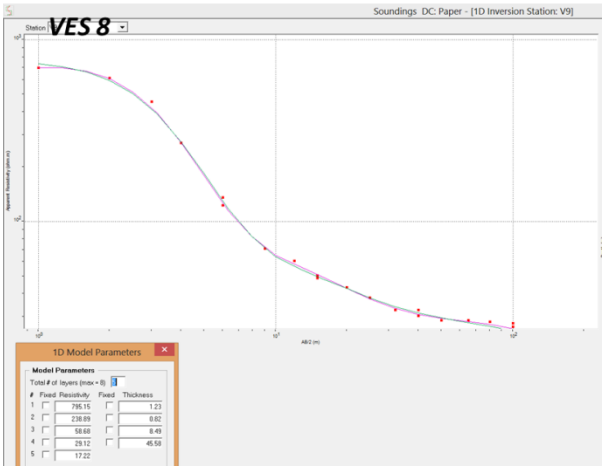

VES 3
Soundings DC: Paper - [1D Inversion Station: V4]
1D Model Parameters
Model Parameters
Total # of layers (max = 8)
Fixed Resistivity Fixed Thickness
1 666.00 1.47
2 44.09 5.94
3 76.88 14.86
4 24.23

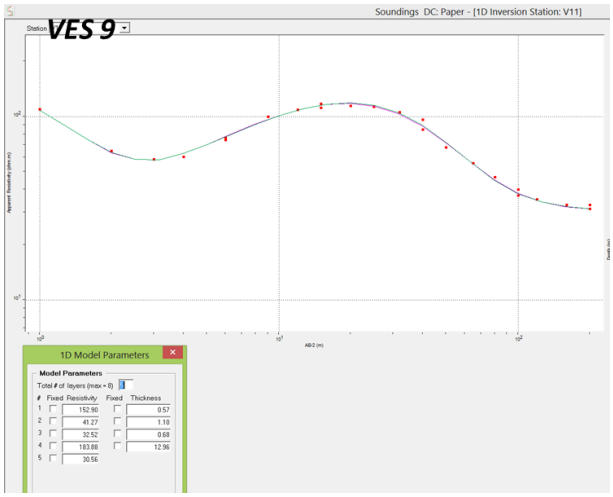

VES 4
Soundings DC: Paper - [1D Inversion Station: V5]
1D Model Parameters
Model Parameters
Total # of layers (max = 8)
Fixed Resistivity Fixed Thickness
1 1243.28 1.46
2 404.66 0.90
3 98.36 7.01
4 48.22 22.87
5 19.10

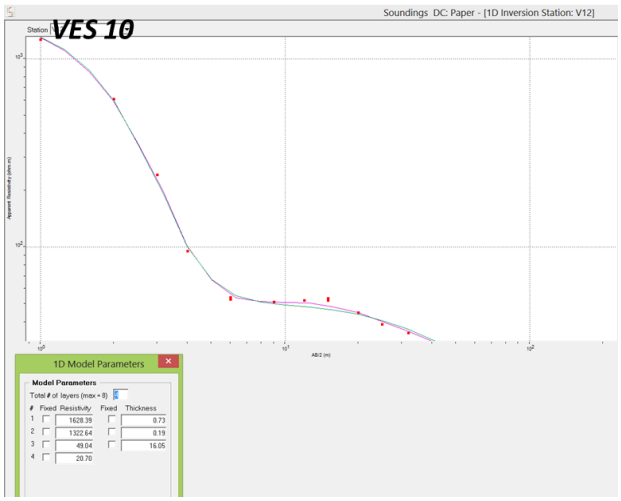

VES 5
Soundings DC: Paper - [1D Inversion Station: V6]
1D Model Parameters
Model Parameters
Total # of layers (max = 8)
Fixed Resistivity Fixed Thickness
1 1169.10 0.34
2 2662.61 0.89
3 49.88 5.89
4 131.50 39.91
5 38.58

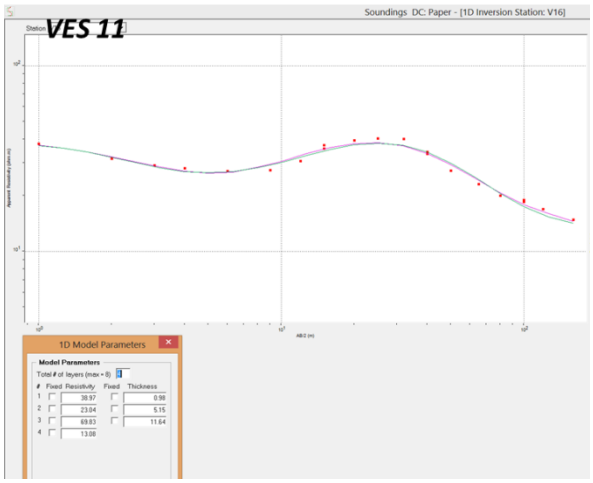

VES 6
Soundings DC: Paper - [1D Inversion Station: V7]
1D Model Parameters
Model Parameters
Total # of layers (max = 8)
Fixed Resistivity Fixed Thickness
1 1452.62 1.51
2 618.44 0.66
3 38.59 5.16
4 177.82 14.37
5 51.13

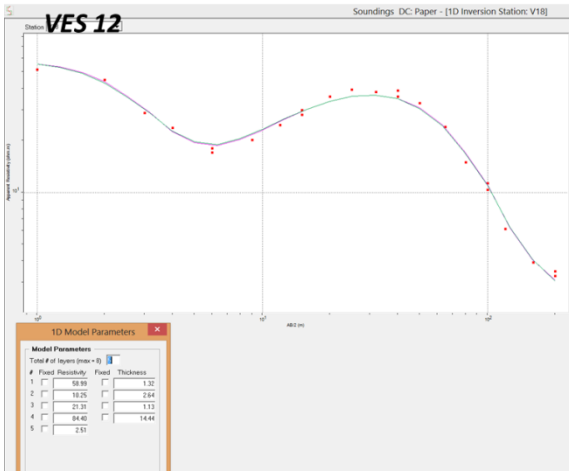

Soundings DC: Paper - [1D Inversion Station: V8]
Station
VES 7
1D Model Parameters
Model Parameters
Total # of layers (max = 8)
Fixed Resistivity Fixed Thickness
1 610.98 0.92
2 252.36 0.38
3 70.63 4.96
4 15.35 27.28
5 2.74


Soundings DC: Paper - [1D Inversion Station: V9]
Station
VES 8
1D Model Parameters
Model Parameters
Total # of layers (max = 8)
Fixed Resistivity Fixed Thickness
1 795.15 1.23
2 238.89 0.82
3 58.68 8.49
4 29.12 45.58
5 17.22


Soundings DC: Paper - [1D Inversion Station: V11]
Station
VES 9
1D Model Parameters
Model Parameters
Total # of layers (max = 8)
Fixed Resistivity Fixed Thickness
1 152.90 0.57
2 41.27 1.18
3 32.52 0.68
4 183.88 12.96
5 30.56


Soundings DC: Paper - [1D Inversion Station: V12]
Station
VES 10
1D Model Parameters
Model Parameters
Total # of layers (max = 8)
Fixed Resistivity Fixed Thickness
1 1628.29 0.73
2 1322.64 0.19
3 49.04 16.05
4 20.70


VES 11
Soundings DC: Paper - [1D Inversion Station: V16]
Station
1D Model Parameters
Model Parameters
Total # of layers (max = 8)
Fixed Resistivity Fixed Thickness
1 38.97 0.98
2 23.04 5.15
3 69.83 11.64
4 13.08


VES 12
Soundings DC: Paper - [1D Inversion Station: V18]
Station
1D Model Parameters
Model Parameters
Total # of layers (max = 8)
Fixed Resistivity Fixed Thickness
1 58.99 1.32
2 10.25 2.64
3 21.31 1.13
4 84.40 14.44
5 2.51