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Assessment of the Impact of automobile Waste on the Environment

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ABSTRACT : *This study is on automobile waste penetration, the depth and thickness of the contaminated area by the use of vertical electrical sounding and horizontal resistivity profiling. Schlumberger and Wenner array was employed in the resistivity sounding and profiling, using an Abem SAS 300B terrameter. In this survey, electrodes were arranged in a straight line with constant spacing and connected to multicore cables. The field survey was conducted along four profiles which provide a continuous coverage of electrical sounding and profiling. The surface soil material is mainly sands. The result showed that profile line 4(Vertical Electrical Sounding I) has the highest depth of automobile wastes penetration which is about 60m while profile line 3 (Vertical Electrical Sounding 3) has the least depth of automobile wastes penetration which is about 0.4m. Also, profile line 3 has the highest thickness of the contaminated area which is about 14m while profile line 4, has the least thickness of contaminated area which is about 5m. The result of this work could serve as a baseline study for future evaluation of automobile wastes, when allocating site to Automobile workshop.*
KEYWORDS: *automobile waste, electrical sounding, waste penetration, resistivity, profiling, automobile workshop*

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I. INTRODUCTION

Automobile waste such as used lubricating oil, used grease, contaminated petrol and diesel, acid and calcium carbide are generated from Auto-mechanic workshops that repair and service auto-mobiles. These wastes are not properly disposed of, since there is hardly any stipulated law regulating their locations, activities and operations.

These workshops create and discharge automobile wastes into our environment (soil) some of which add dirty or harmful substances to air so that it is no longer pleasant or safe to use. These wastes are possible and available sources of environmental pollution if not properly get rid of and managed.

The common method used by the users of these wastes and operators of automobile workshops to get rid of these wastes is by pouring them on the ground which either penetrate into the soil or washed by rainstorm into drains. When used lubricating oil is poured down drains or onto the ground, the oil is not water down. Oil that is not properly getting rid of will find its way into the soil.

The result of this study will provide information about the lateral extent and vertical depth of penetration of used lubricating oil, contaminated petrol/diesel and used grease and their relationship with existing borehole (hydraulic head). This information could serve as a baseline study for future evaluation of automobile and polycylic aromatic hydrocarbons (PAHS) pollution in Elekhia (Nigeria) mechanic village soils and providing allocation for automobile workshop. Although there are varieties of waste generated in a workshop, the automobile wastes to be study in this work are used lubricating oil, contaminated petrol and diesel used grease, acid and calcium carbide. The field base physical parameters of the existing bore-hole (hydraulic head) such as colour, odour and taste were study.

II. METHODOLOGY

2.1 Sources of Data:

The method of data collection was primary because the data were collected afresh and for the first time and thus happen to be original in character. Unlike the secondary data which have already been collected by someone else and which have already been passed through the statistical process. In this case the researcher is certainly not confronted with the problems that are usually associated with the collection of primary data. The required information was collected through the use of electrical devices.

2.2 Methods of Data Collection

The automobile workshop is divided into four section identified as profile line 1, 2, 3 and 4. This is because the structure of the automobile workshop (workshop setting) has four sections. Although, there are three (3) Vertical Electrical Sounding and one (1) Horizontal Resistivity Profiling measurement employing half schlumberger and Wenner array was carried out on each profile line using an instrument called ABEM SAS 300B terrameter.

2.3 Method used in obtaining the Data for Vertical Electrical Sounding (VES)

The vertical Electrical Sounding data was obtained using an electrode array known as Schlumbergeer. The geometric factor for half schlumberger configuration is given by the equation below:

$$K = \frac{\left[\left(\frac{AB}{2}\right)^2 - \left(\frac{MN}{2}\right)^2 \right]}{2MN} \times \pi \quad \ldots\ldots\ldots\ldots 1$$

Where AB is the distance between the current electrodes
MN is the distance between the potential electrodes

$\pi = 3.142$ or $\frac{22}{7}$

Apparent resistivity (e) such that

$$e = K \times R \quad \ldots\ldots\ldots\ldots 2$$

Where R is resistance read on the MiniRes

Table.1: Vertical Electrical Sounding 1, 2 and 3 Data Sheet for Profile Line One

AB/2	MN/2	K	VES 1 R1	ρ1	VES 2 R2	ρ2	VES 3 R3	ρ3
1	0.25	0.9375	3.5	3.28125	4.56	4.275	1.05	0.9843
1.5	0.25	2.1875	5.84	12.775	7.65	16.7343	2.031	4.4428
2	0.25	100.14	10.42	1043.459	11.32	1133.585	3.042	304.6259
3	0.25	225.80	15.93	3596.994	14.42	3256.036	5.04	1138.032
4	0.5	200.28	21.12	4229.914	17.41	3486.875	4.03	807.1284
4	0.25	401.73	32.01	12859.38	22.41	9002.769	3.05	1225.277
5	0.5	313.37	25.12	7871.854	28.6	8962.382	2.08	651.8096
6	0.5	451.60	17.73	8006.868	30.32	13692.51	1.091	492.6956
8	0.5	803.46	11.21	9006.787	20.23	16254	0.921	739.9867
10	1	626.75	8.23	5158.153	16.12	10103.21	0.682	427.4435
10	0.5	1255.85	6.23	7823.946	8.32	10448.67	0.461	578.9469
15	1	1412.15	4.231	5974.807	4.45	6284.068	0.234	330.4431
20	1	2511.70	2.02	5073.634	2.03	5098.751	0.172	432.0124
30	1	5653.30	0.93	5257.569	0.54	3052.782	0.0984	556.2847
40	2.5	4017.31	0.321	1289.557	0.094	377.6271	0.0704	282.8186
40	1	10051.53	0.023	231.1852	0.0085	85.43801	0.058	582.9887
50	2.5	6279.26	0.342	2147.507	0.0043	27.00082	0.045	282.5667
60	2.5	9043.86	0.001	9.04386	0.0023	20.80088	0.0321	290.3079
80	2.5	16081.03	0.0034	54.6755	0.0011	17.68913	0.0065	104.5267
100	10	6267.48	0.0067	41.99212	0.0321	201.1861	0.0043	26.95016
100	2.5	25128.81	0.0065	163.3373	0.0043	108.0539	0.0032	80.41219
150	10	14121.46	0.076	1073.231	0.0045	63.54657	0.0016	22.59434
200	10	25117.03	0.0078	195.9128	0.041	1029.798	0.0012	30.14044

2.4 Geometric factor and apparent resistivity

The generalized formula for calculating geometric factor (Kg) for a four-electrode configuration is:

$$Kg = 2\pi \left(\frac{1}{C_1 P_1} - \frac{1}{C_1 P_2} - \frac{1}{C_2 P_1} + \frac{1}{C_2 P_2} \right)^{-1} \quad \ldots\ldots\ldots\ldots 3$$

Where, C_1 and C_2, and P_1 and P_2, are the current and potential electrode positions respectively.

Table 2 Horizontal Resistivity Profiling Data Sheet 1

5m spacing							10m spacing						
C1	P1	P2	C2	K	R	ϱ	C1	P1	P2	C2	K	R	ϱ
0	5	10	15	31.42	5.3	166.526	0	10	20	20	64.83	8	518.64
5	10	15	20	31.42	0.05	1.571	10	20	30	40	64.83	5.4	350.082
10	15	20	25	31.42	7	219.94	20	30	40	50	64.83	6.3	408.429
15	20	25	30	31.42	3.5	109.97	30	40	50	60	64.83	2.1	136.143
20	25	30	35	31.42	3.24	101.8008	40	50	60	70	64.83	4	259.32
25	30	35	40	31.42	3.18	99.9156	50	60	70	80	64.83	7	453.81
30	35	40	45	31.42	3.82	120.0244	60	70	80	90	64.83	8	518.64
35	40	45	50	31.42	3.27	102.7434	70	80	90	100	64.83	9	583.47
						4							
40	45	50	55	31.42	3.45	108.399	80	90	100	105	64.83	12	777.96
45	50	55	60	31.42	3.96	124.4232	90	100	110	120	64.83	14	907.62
50	55	60	65	31.42	1.16	36.4472	100	110	120	130	64.83	2	129.66
55	60	65	70	31.42	0.86	27.0212	110	120	130	140	64.83	3.9	252.837
60	65	70	75	31.42	4.08	128.1936	120	130	140	150	64.83	0.987	63.98721
65	70	75	80	31.42	3.89	122.2238	130	140	150	160	64.83	5.3	343.599
70	75	80	85	31.42	2.09	65.6678	140	150	160	170	64.83	2.12	137.4396
75	80	85	90	31.42	3.05	95.831	150	160	170	180	64.83	9.4	609.402
80	85	90	95	31.42	2.8	87.976	15m spacing						
85	90	95	100	31.42	3.36	105.5712	C1	P1	P2	C2	K	R	ϱ
90	95	100	105	31.42	3.31	104.0002	0	15	30	45	94.25	9	848.25

95	100	105	110	31.42	2.78	87.3476	15	30	45	60	94.25	4	377
100	105	110	115	31.42	3.57	112.1694	30	45	60	75	94.25	3	282.75
105	110	115	120	31.42	1.96	61.5832	45	60	75	90	94.25	5	471.25
110	115	120	125	31.42	3.76	118.1392	60	75	90	105	94.25	6	565.5
115	120	125	130	31.42	4.39	137.9338	75	90	105	120	94.25	0.3	28.275
120	125	130	135	31.42	3.87	121.5954	90	105	120	135	94.25	2.72	256.36
125	130	135	140	31.42	0.917	28.81214	105	120	135	150	94.25	0.43	40.5275
130	135	140	145	31.42	1.35	42.417	120	135	150	165	94.25	0.21	19.7925
135	140	145	150	31.42	0.623	19.57466	135	150	165	180	94.25	0.876	82.563
140	145	150	155	31.42	3.1	97.402	**20m spacing**						
145	150	155	160	31.42	2.71	85.1482	**C1**	**P1**	**P2**	**C2**	**K**	**R**	**ρ**
150	155	160	165	31.42	4.59	144.2178	0	20	40	60	125.66	4	502.64
155	160	165	170	31.42	5.19	163.0698	20	40	60	80	125.66	3	376.98
160	165	170	175	31.42	5.51	173.1242	40	60	80	100	125.66	6	753.96
165	170	175	180	31.42	2.9	91.118	60	80	100	120	125.66	7	879.62
							80	100	120	140	125.66	8	1005.28
							100	120	140	160	125.66	11	1382.26
							120	140	160	180	125.66	21	2638.86

2.5 Methods of Data Analysis

The vertical electrical sounding (VES) data were used to determine the possible depth of automobile waste penetration while the Horizontal resistivity profiling (HRP) data were used to determine the possible plumes and lateral extent that is the thickness of the contaminated area. Vertical Electrical Sounding (VES) data were inputted to the computer and curves were plotted using 1X1D version 3.44 interpretation software as shown in figure1 to figure 12.

2.6 Total Thickness of Contaminated Area

To calculate the total thickness of the contaminated area for profile line 1, 2, 3 and 4 we use the arithmetic mean formula given as

$$\bar{x} = \frac{\sum_{i=1} x_i}{n} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

Where, $\bar{X}$ is the arithmetic mean and the divisor n is the total number of items so added. The subscript i go from 1 to n and indicate the position of each observation in the set.

Table 3 Number of Plumes on profile line 1, 2 3 and 4, as obtained from Figure 13-16

Thickness of the Contaminated area (m) / Plumes / Profile lines	1	2	3	4	5	
	t_1(m)	t_2(m)	t_3(m)	t_4(m)	t_5(m)	Total thickness / Number of Plumes
1	7	10	7	_	_	8
2	5	10	5	10	3	6.6
3	15	20	8	_	_	14.3
4	5	5	_	_	_	5

III. RESULTS AND DISCUSSION

3.1 Presentation of Data

Graph of depth plotted against resistivity and apparent resistivity plotted against spacing obtained from vertical electrical sounding data are presented in Figure 1 to figure 12. The essence of the data and plots is to show the variation of contaminant level with depth and lithology level with depth.

3.2 Data Analysis of Vertical Electrical Sounding

At profile line I (Vertical Electrical Sounding 1), the possible depth of wastes penetration and the inferred lithology were 27m and sands respectively as shown in table 1. This implies that the soil of profile line 1 (Vertical Electrical Sounding 2) is severely polluted with this automobile wastes.

At profile line 1 (Vertical Electrical Sounding 2), the possible depth of wastes penetration and the inferred lithology were 6m and gravels respectively as shown in table 2. This implies that the soil of profile line 1 (Vertical Electrical Sounding 2) is moderately polluted with this automobile wastes.

At profile line 1 (Vertical Electrical Sounding 3), the possible depth of wastes penetration and the inferred lithology were 22m and sands respectively as shown in table 3. This implies that the soil of profile line 1 (Vertical Electrical Sounding 3) is severely polluted with this automobile wastes.

At profile line 2 (Vertical Electrical Sounding 1), the possible depth of wastes penetration and the inferred lithology were 11m and sands respectively as shown in table 4. This implies that the soil of profile line 2 (Vertical Electrical Sounding 1) is severely polluted with this automobile wastes.

At profile line 2 (Vertical Electrical Sounding 2), the possible depth of wastes penetration and the inferred lithology were 4m and sandy clays respectively as shown in table 5. This implies that the soil of profile line 2 (Vertical Electrical Sounding 2) is moderately polluted with this automobile wastes.

At profile line 2 (Vertical Electrical Sounding 3), the possible depth of wastes penetration and the inferred lithology were 12m and sandy clays respectively as shown in table 6. This implies that the soil of profile line 2 (Vertical Electrical Sounding 3) is severely polluted with this automobile wastes.

At profile line 3 (Vertical Electrical Sounding 1), the possible depth of waste penetration and the inferred lithology were 1m and sands respectively as shown in table 7. This implies that the soil of profile line 3 (Vertical Electrical Sounding 1) is slightly polluted with this automobile wastes.

At profile line 3 (Vertical Electrical Sounding 2), the possible depth of wastes penetration and the inferred lithology were 6m and sandy respectively as shown in table 8. This implies that the soil of profile line 3, (Vertical Electrical Sounding 2) is moderately polluted with this automobile wastes.

At profile line 3 (Vertical Electrical Sounding 3), the possible depth of waste penetration and inferred lithology were 0.4m and sands respectively as shown in table 9. This implies that the soil of profile line 3, (Vertical Electrical Sounding 3) is slightly polluted with this automobile wastes.

At profile line 4 (Vertical Electrical Sounding 1), the possible depth of wastes penetration and the inferred lithology were 60m and sandy clays as shown in table 10. This implies that the soil of profile line 4, (Vertical Electrical Sounding 1) is severely polluted with this automobile wastes.

At profile line 4 (Vertical Electrical Sounding 2), the possible depth of wastes penetration and inferred lithology were 48m and sands respectively as shown in table11. This implies that the soil of profile line 4, (Vertical Electrical Sounding 2) is severely polluted with this automobile wastes.

At profile line 4 (Vertical Electrical Sounding 3), the possible depth of wastes penetration and the inferred lithology were 0.5m and sandy clays respectively as shown in table 12. This implies that the soil of profile line 4, (Vertical Electrical Sounding 3) is slightly polluted with this automobile wastes.

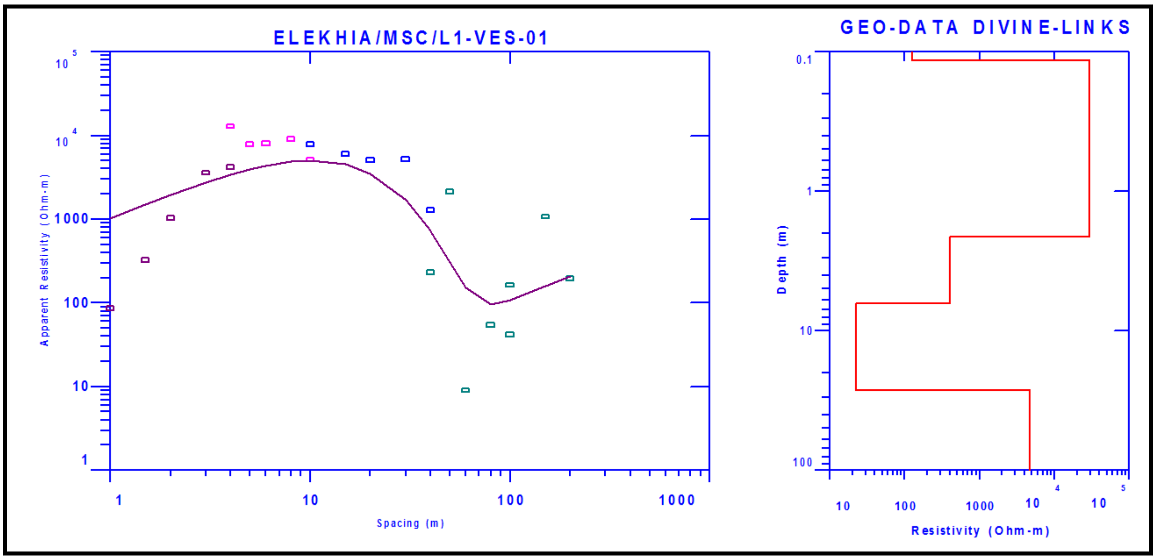


Figure 1: Graph of Depth against Resistivity and Apparent Resistivity against Spacing

Table 1 (Profile Line 1, Vertical Electrical Sounding 1)

LAYERS #	RESISTIVITY(Ωm)	THICKNESS(m)	DEPTH(m)	INFERRED LITHOLOGY
1	126.03	0.11604	0.11604	Topsoil
2	29816.	1.9895	2.1055	Clays
3	404.99	4.2299	6.3354	Sandy Clays
4	22.560	20.269	26.605	Sands
5	4654.9	∞	∞	Clayey Sands

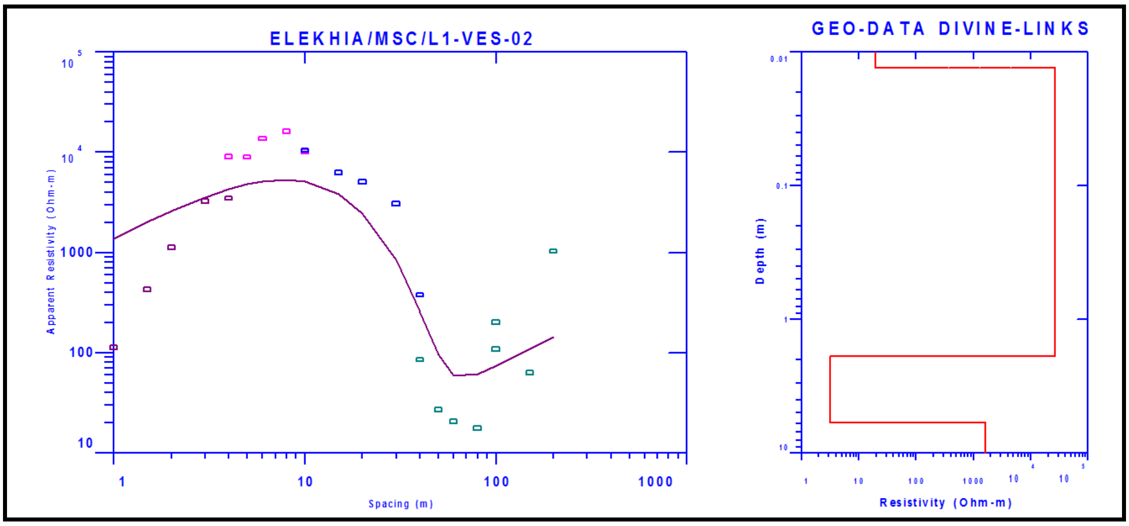


Figure 2: Graph of Depth against Resistivity and Apparent Resistivity against Spacing

Table 2 (Profile Line 1, Vertical Electrical Sounding 2)

LAYERS #	RESISTIVITY(Ωm)	THICKNESS(m)	DEPTH(m)	INFERRED LITHOLOGY
1	19.638	0.13149E-01	0.13149E-01	Topsoil
2	26852.	1.8665	1.8797	Clays
3	3.1491	4.0183	5.8980	Sandy gravels
4	1611.5	∞	∞	Sandy clays

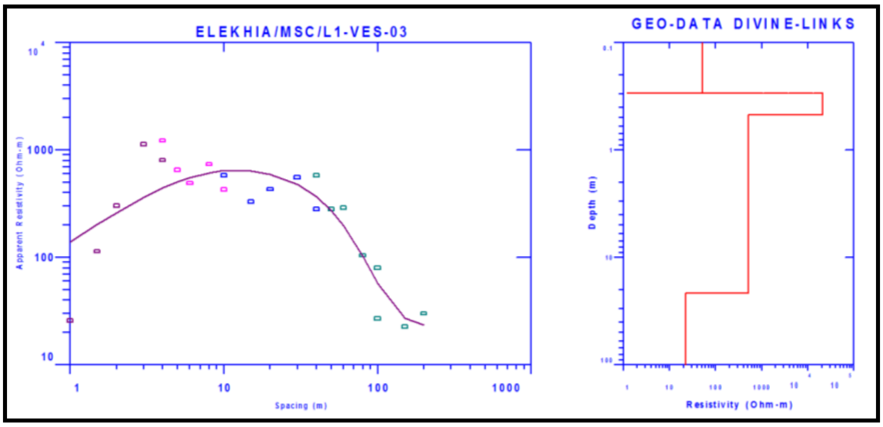


Figure 3: Graph of Depth against Resistivity and Apparent Resistivity against Spacing

Table 3 (Profile Line 1, Vertical Electrical Sounding 3)

LAYERS #	RESISTIVITY(Ωm)	THICKNESS(m)	DEPTH(m)	INFERRED LITHOLOGY
1	51.353	0.29517	0.29517	Topsoil
2	1.1911	0.13014E-02	0.29647	Sands
3	21128.	0.17246	0.46893	Clays
4	519.75	21.122	21.591	Sands
5	22.257	∞	∞	Gravelly Sands

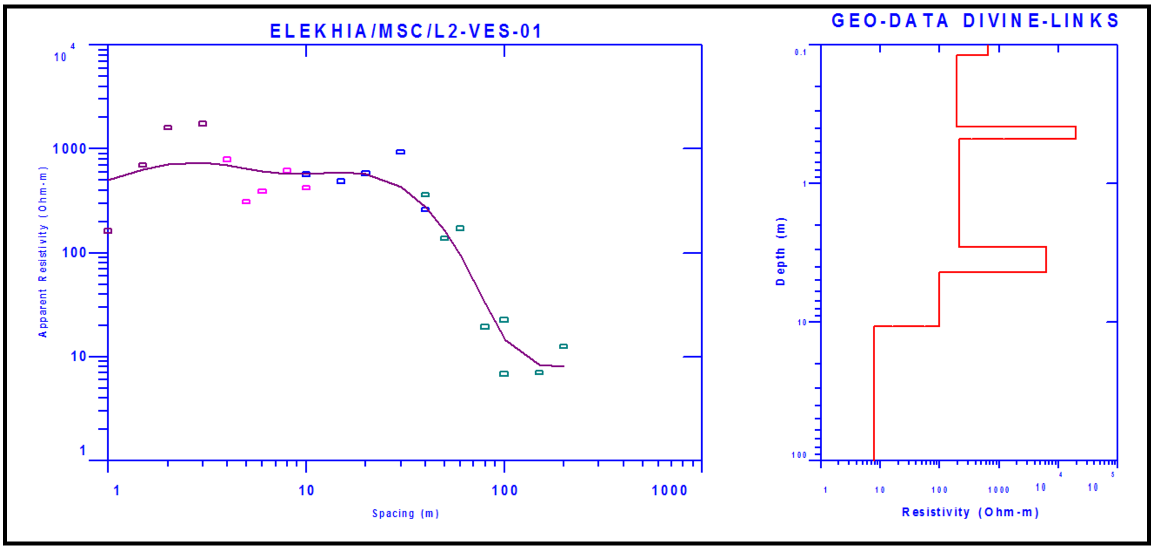


Figure 4: Graph of Depth against Resistivity and Apparent Resistivity against Spacing

Table 4 (Profile Line 2, Vertical Electrical Sounding 1)

LAYERS #	RESISTIVITY(Ωm)	THICKNESS(m)	DEPTH(m)	INFERRED LITHOLOGY
1	660.77	0.11830	0.11830	Topsoil
2	194.00	0.27285	0.39115	Clayey Sands
3	19420.	0.83807E-01	0.47496	Clays
4	214.68	2.3842	2.8592	Sandy Clays
5	6318.9	1.5259	4.3851	Silty Clays
6	98.320	6.3106	10.696	Sands
7	7.8617	∞	∞	Gravelly Sands

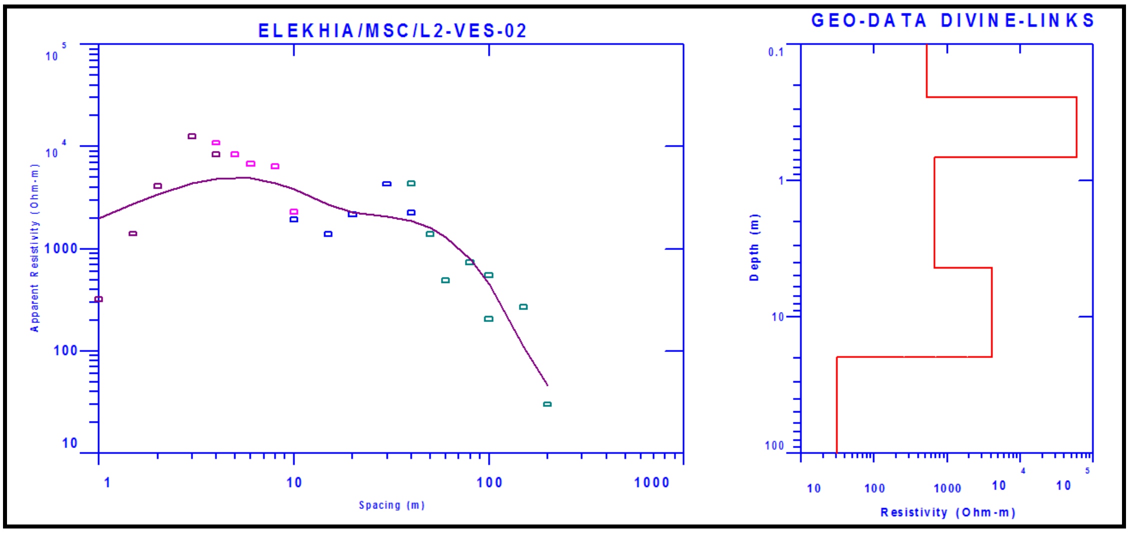


Figure 5 Graph of Depth against Resistivity and Apparent Resistivity against Spacing

Table 5 (Profile Line 2, Vertical Electrical Sounding 2)

LAYERS #	RESISTIVITY	THICKNESS(m)	DEPTH(m)	INFERRED LITHOLOGY
1	531.12	0.24444	0.24444	Topsoil
2	58702.	0.43372	0.67816	Clays
3	682.82	3.6909	4.3690	Sandy Clays
4	4141.4	15.423	19.792	Clays
5	31.590	∞	∞	Sands

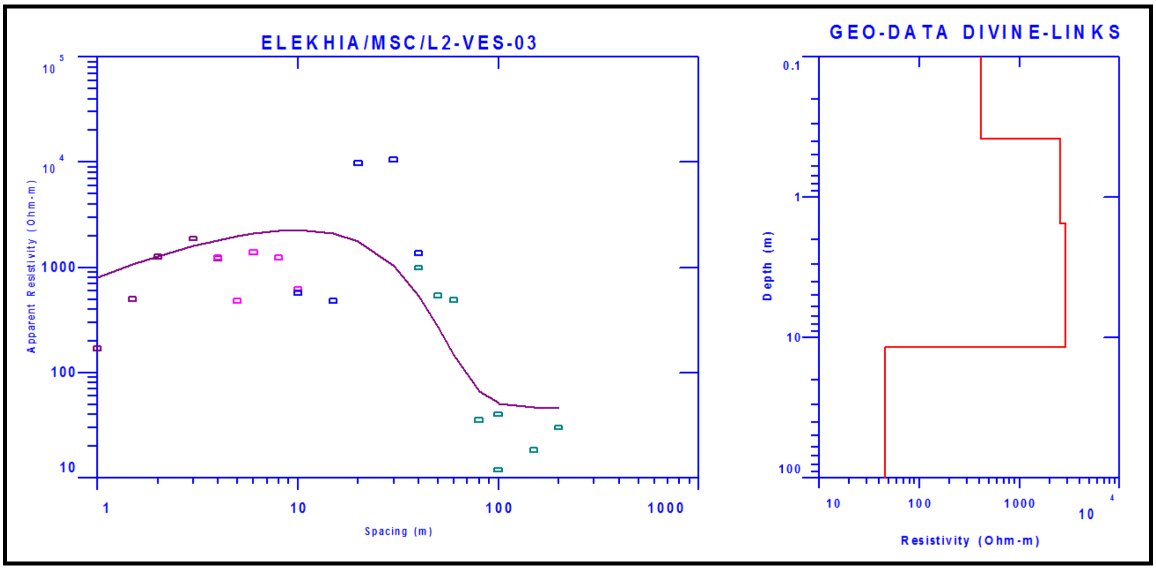


Figure 6: Graph of Depth against Resistivity and Apparent Resistivity against Spacing

Table 6 (Profile Line 2, Vertical Electrical Sounding 3)

LAYERS #	RESISTIVITY(Ωm)	THICKNESS(m)	DEPTH(m)	INFERRED LITHOLOGY
1	411.28	0.38300	0.38300	Topsoil
2	2580.4	1.1566	1.5396	Clays
3	2867.1	10.141	11.681	Sandy Clays
4	45.583	∞	∞	Sands

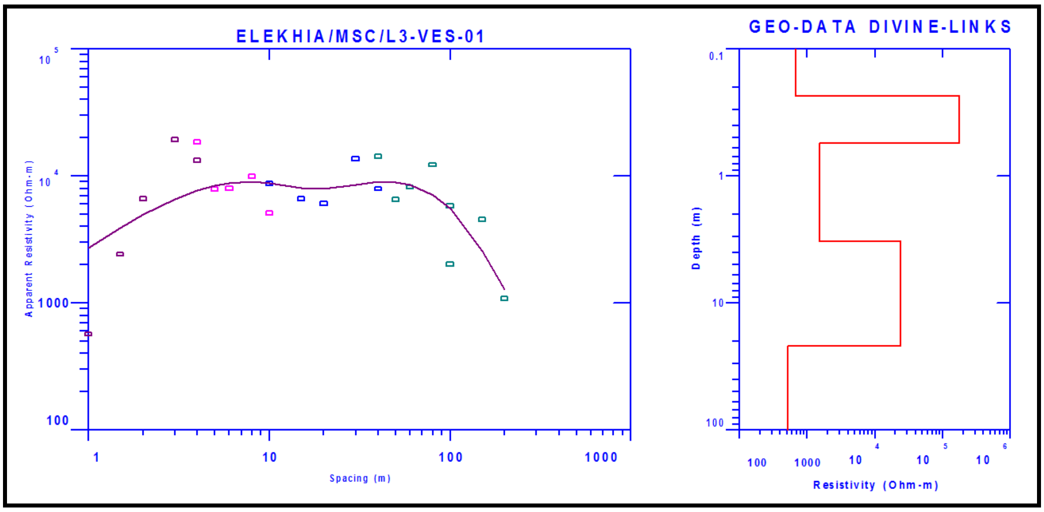


Figure 7: Graph of Depth against Resistivity and Apparent Resistivity against Spacing

Table 7 (Profile Line 3, Vertical Electrical Sounding 1)

LAYERS #	RESISTIVITY(Ωm)	THICKNESS(m)	DEPTH(m)	INFERRED LITHOLOGY
1	680.78	0.23402	0.23402	Topsoil
2	0.17429E+06	0.31830	0.55232	Sands
3	1522.4	2.7401	3.2924	Sandy Clays
4	24046.	18.676	21.968	Clayey Sands
5	513.59	∞	∞	Sands

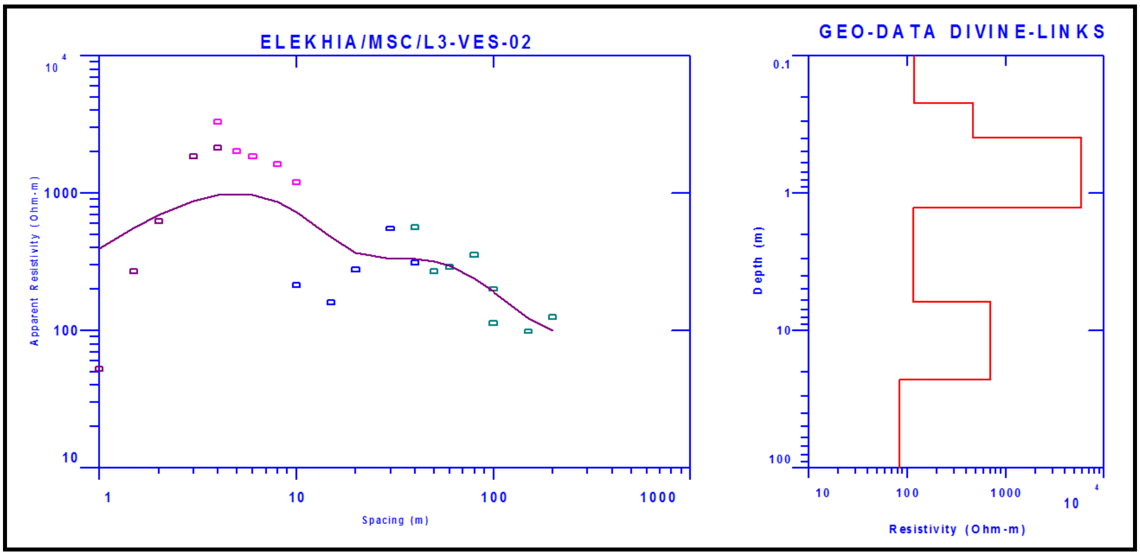


Figure 8: Graph of Depth against Resistivity and Apparent Resistivity against Spacing

Table 8 (Profile Line 3, Vertical Electrical Sounding 2)

LAYERS #	RESISTIVITY	THICKNESS(m)	DEPTH(m)	INFERRED LITHOLOGY
1	117.61	0.22245	0.22245	Topsoil
2	469.06	0.17477	0.39722	Sandy Clay
3	5911.0	0.87523	1.2725	Sandy Clays
4	115.12	4.9087	6.1812	Sands
5	704.70	16.516	22.697	Silty Sands
6	84.048	∞	∞	Gravels

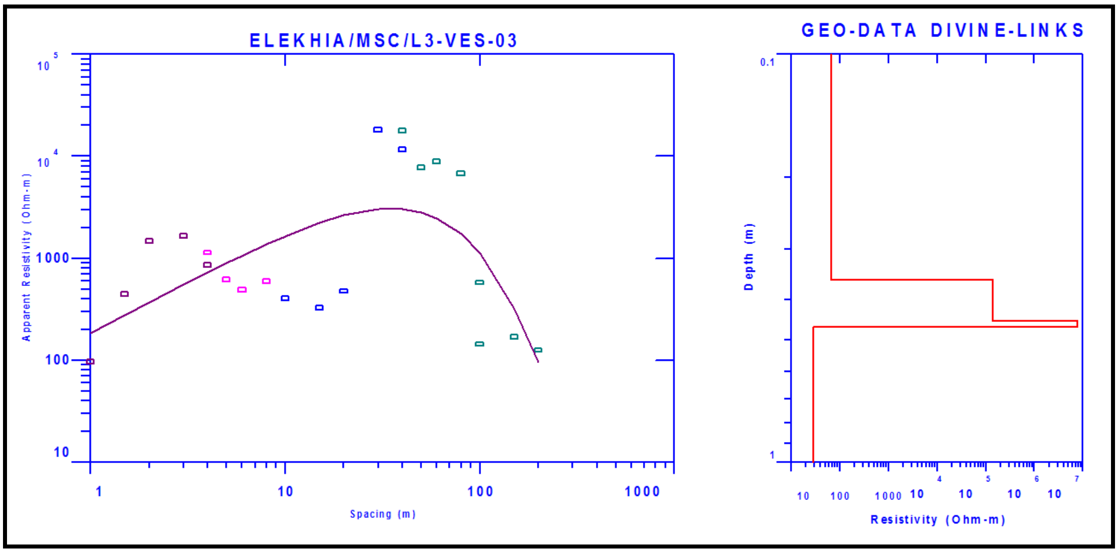


Figure 9: Graph of Depth against Resistivity and Apparent Resistivity against Spacing

Table 9 (Profile Line 3, Vertical Electrical Sounding 3)

LAYERS #	RESISTIVITY	THICKNESS(m)	DEPTH(m)	INFERRED LITHOLOGY
1	67.101	0.35744	0.35744	Topsoil
2	0.14140E+06	0.93264E-01	0.45071	Sands
3	0.76124E+07	0.14953E-01	0.46566	Sands
4	28.274	∞	∞	Gravelly Sands

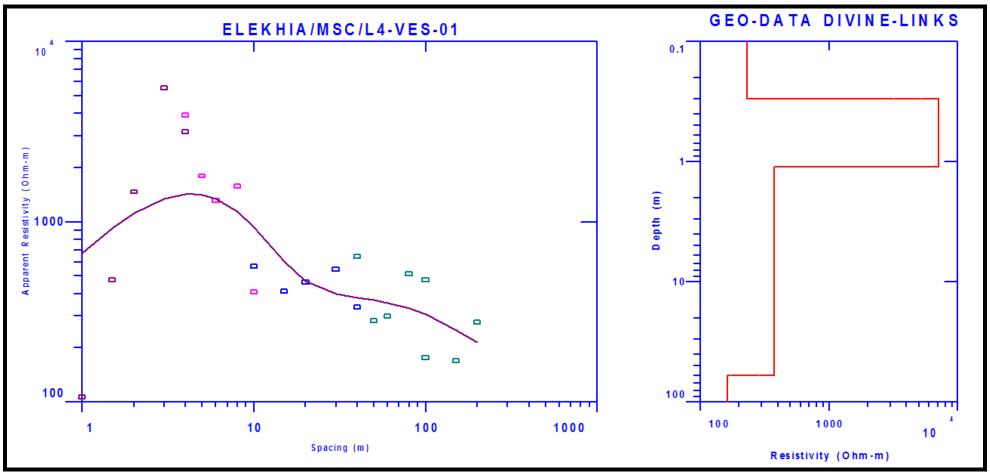


Figure 10: Graph of Depth against Resistivity and Apparent Resistivity against Spacing

Table 10 (Profile Line 4, Vertical Electrical Sounding 1)

LAYERS #	RESISTIVITY	THICKNESS(m)	DEPTH(m)	INFERRED LITHOLOGY
1	232.02	0.30104	0.30104	Topsoil
2	7124.5	0.81109	1.1121	Clays
3	376.00	59.235	60.347	Sandy Clays
4	163.66	∞	∞	Sands

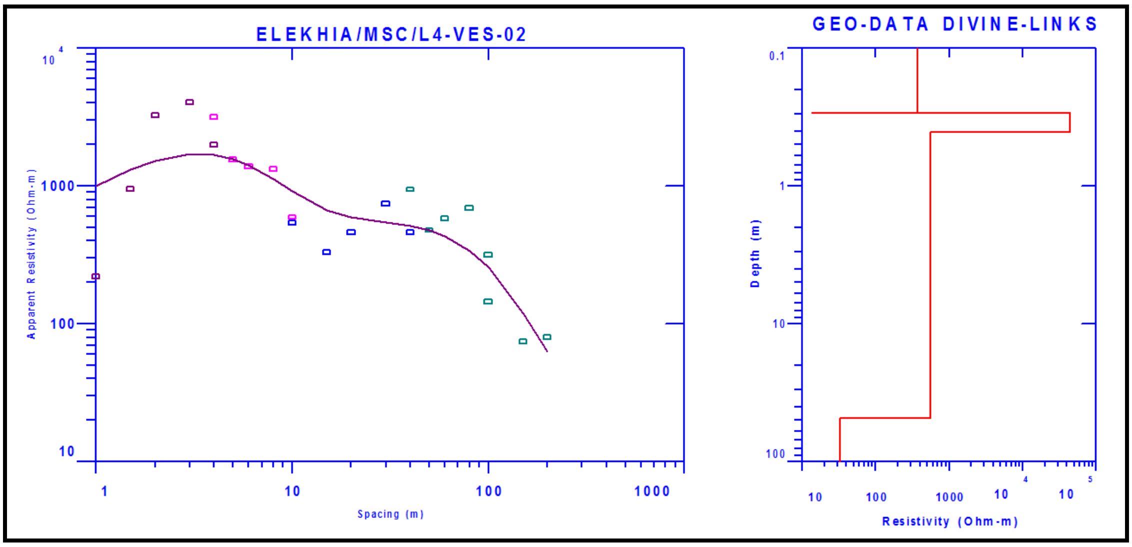


Figure 11: Graph of Depth against Resistivity and Apparent Resistivity against Spacing

Table 11 (Profile Line 4, Vertical Electrical Sounding 2)

LAYERS #	RESISTIVITY	THICKNESS(m)	DEPTH(m)	INFERRED LITHOLOGY
1	373.56	0.29467	0.29467	Topsoil
2	13.586	0.80105E-03	0.29547	Sand
3	43609.	0.11381	0.40928	Clays
4	555.08	47.761	48.170	Sands
5	32.812	∞	∞	Gravelly Sands

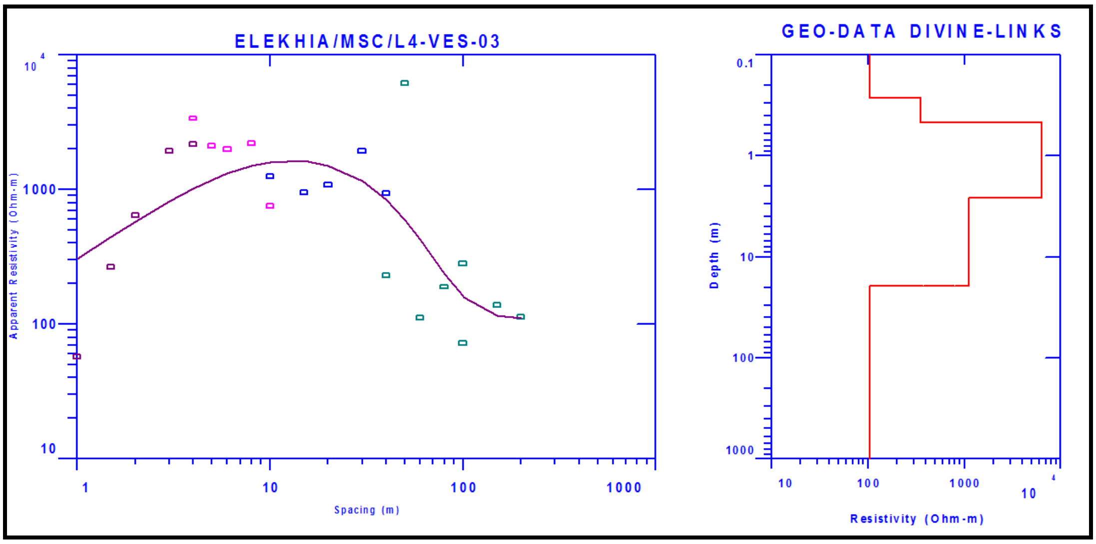


Figure 12: Graph of Depth against Resistivity and Apparent Resistivity against Spacing

Table 12 (Profile Line 4, Vertical Electrical Sounding 3)

LAYERS #	RESISTIVITY	THICKNESS(m)	DEPTH(m)	INFERRED LITHOLOGY
1	105.74	0.26525	0.26525	Topsoil
2	353.48	0.20240	0.46765	Sandy Clays
3	6301.7	2.1378	2.6055	Clays
4	1116.1	16.749	19.354	Clayey Sands
5	105.64	∞	∞	Sands

3.3 Data Analysis of Horizontal Resistivity Profiling

The total thickness of the contaminated area for profile line 1, 2, 3 and are 8m, 6.6m, 14.3m and 5m respectively. This implies that profile line 3 has the highest thickness of contaminated area. This is attributed to engine recycling and dismantling operation and activity, pouring spent engine and transmission oil on the ground. Furthermore, from thorough observation, plants within and around profile line 3 in the automobile workshop are brownish while the soil is dark in colour.

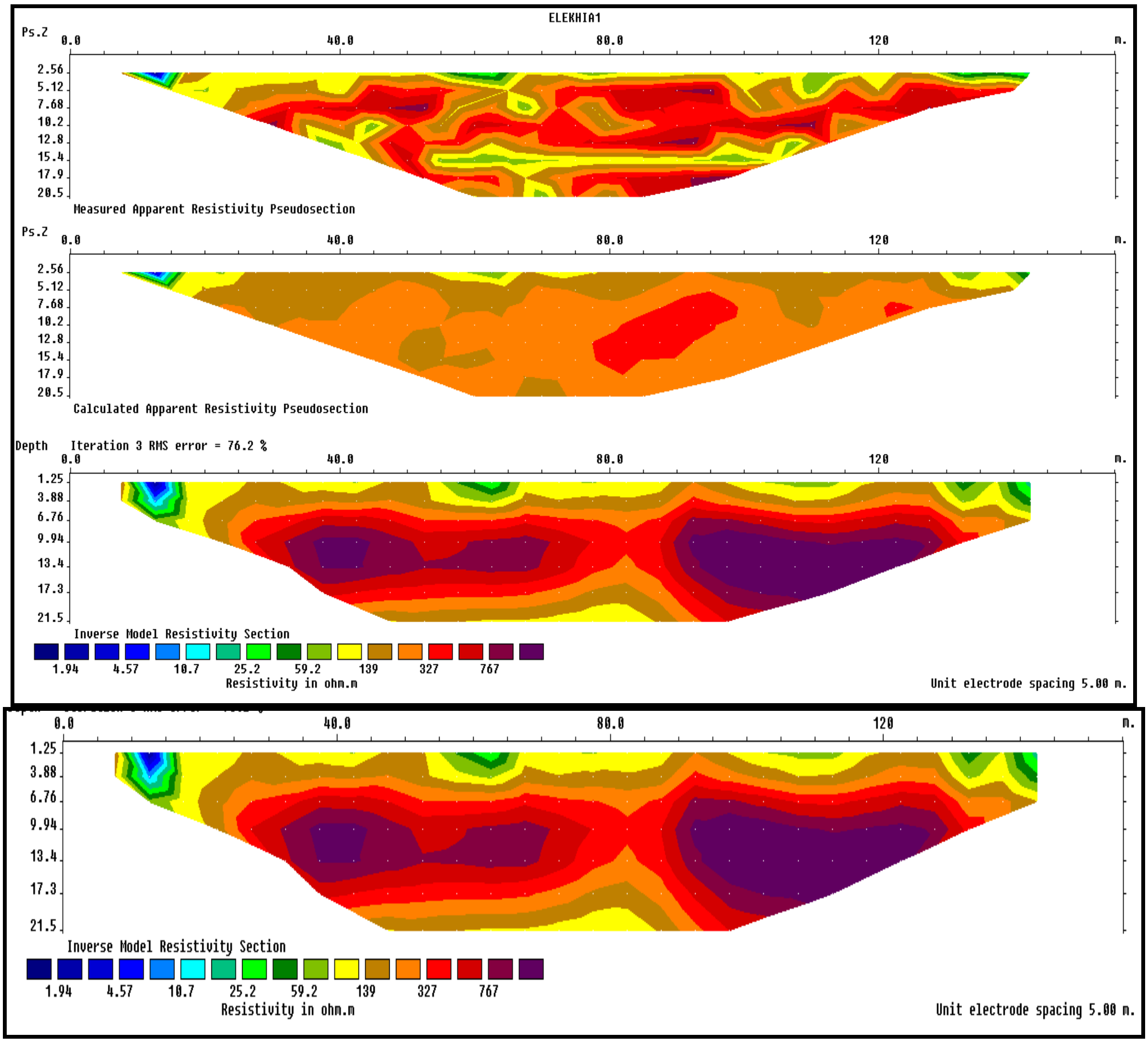
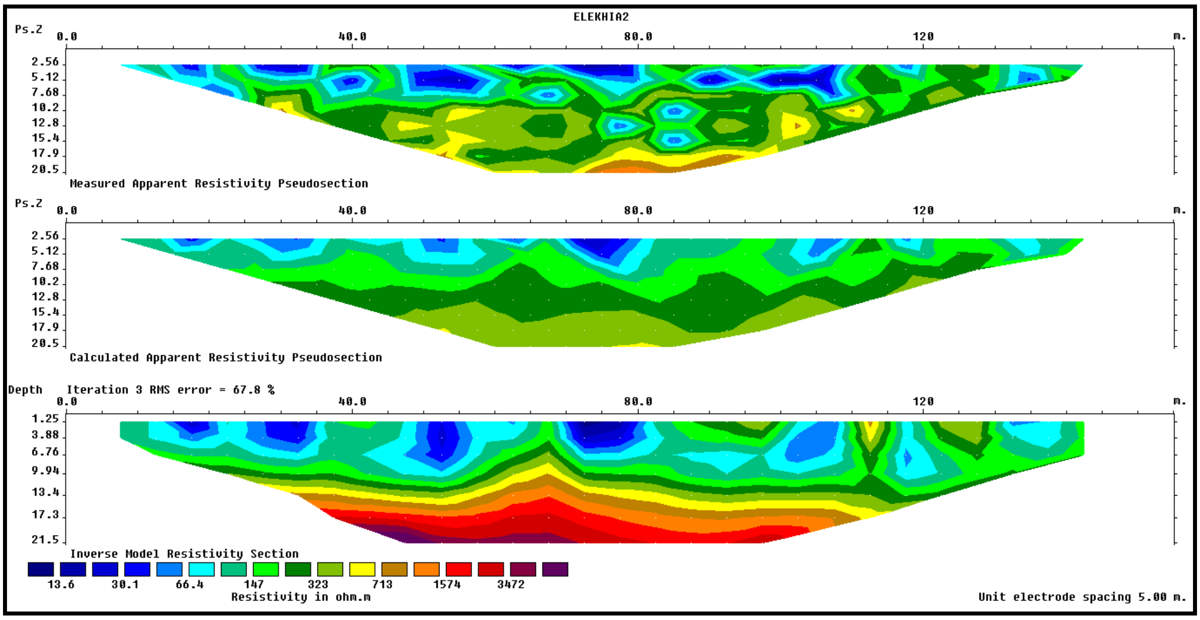


Figure 13: Horizontal Resistivity Profiling 1 (NUMBER OF PLUMES)



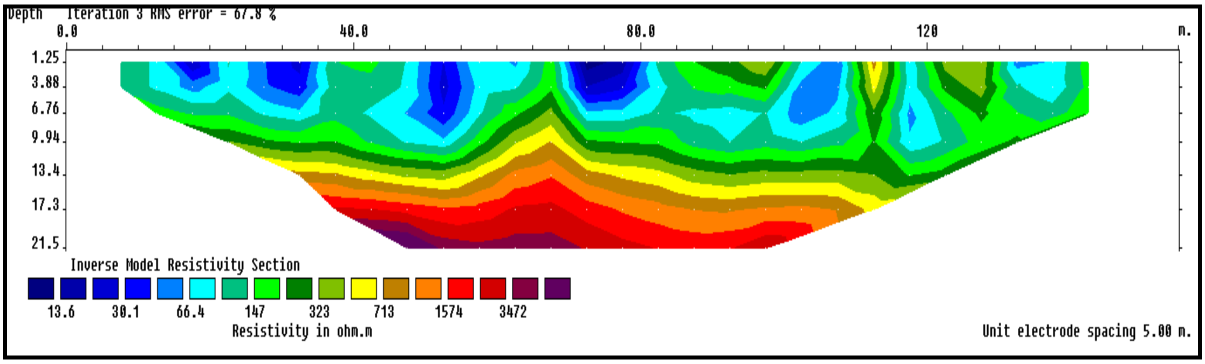


Figure14: Horizontal Resistivity Profiling 2 (NUMBER OF PLUMES)

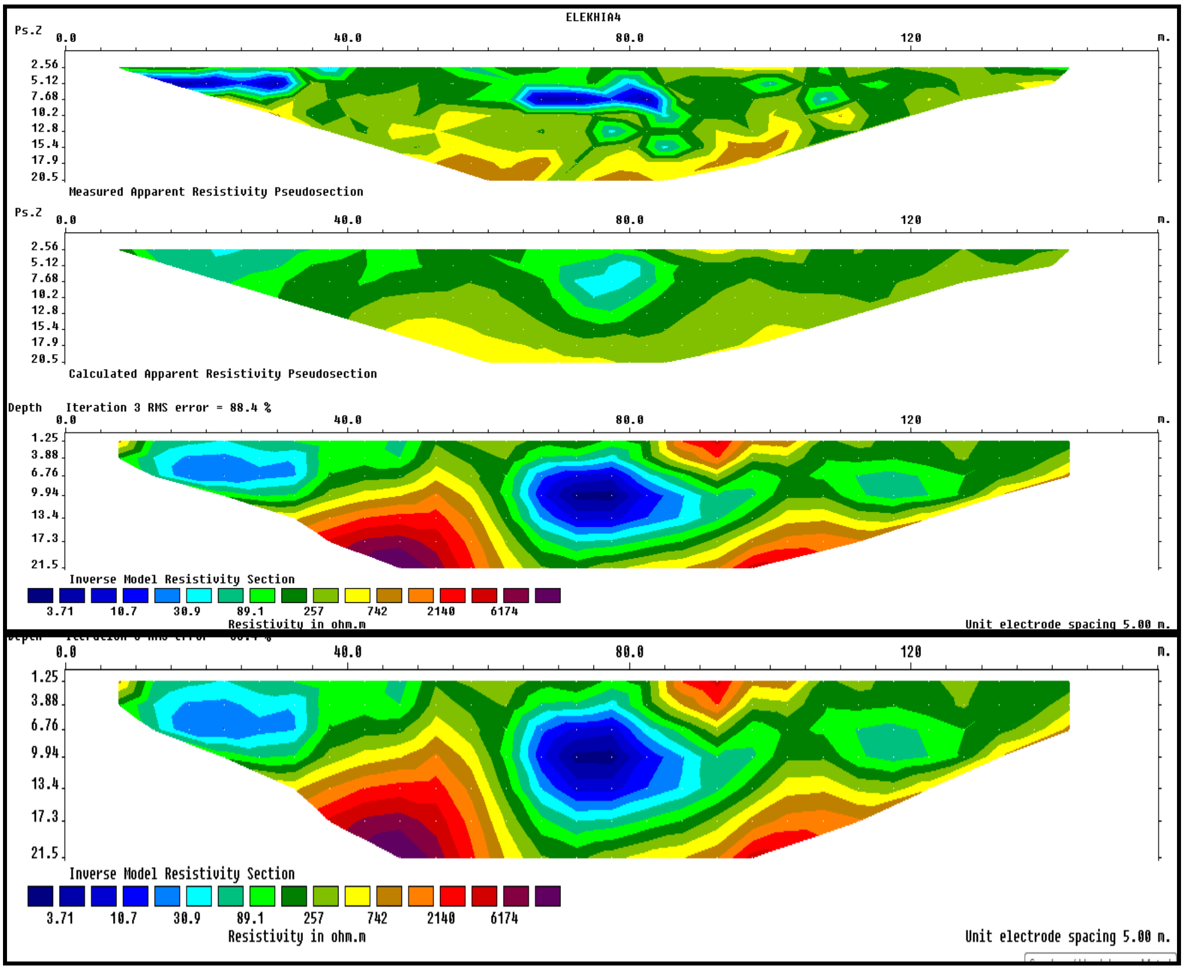


Figure 15: Horizontal Resistivity Profiling 3 (NUMBER OF PLUMES)

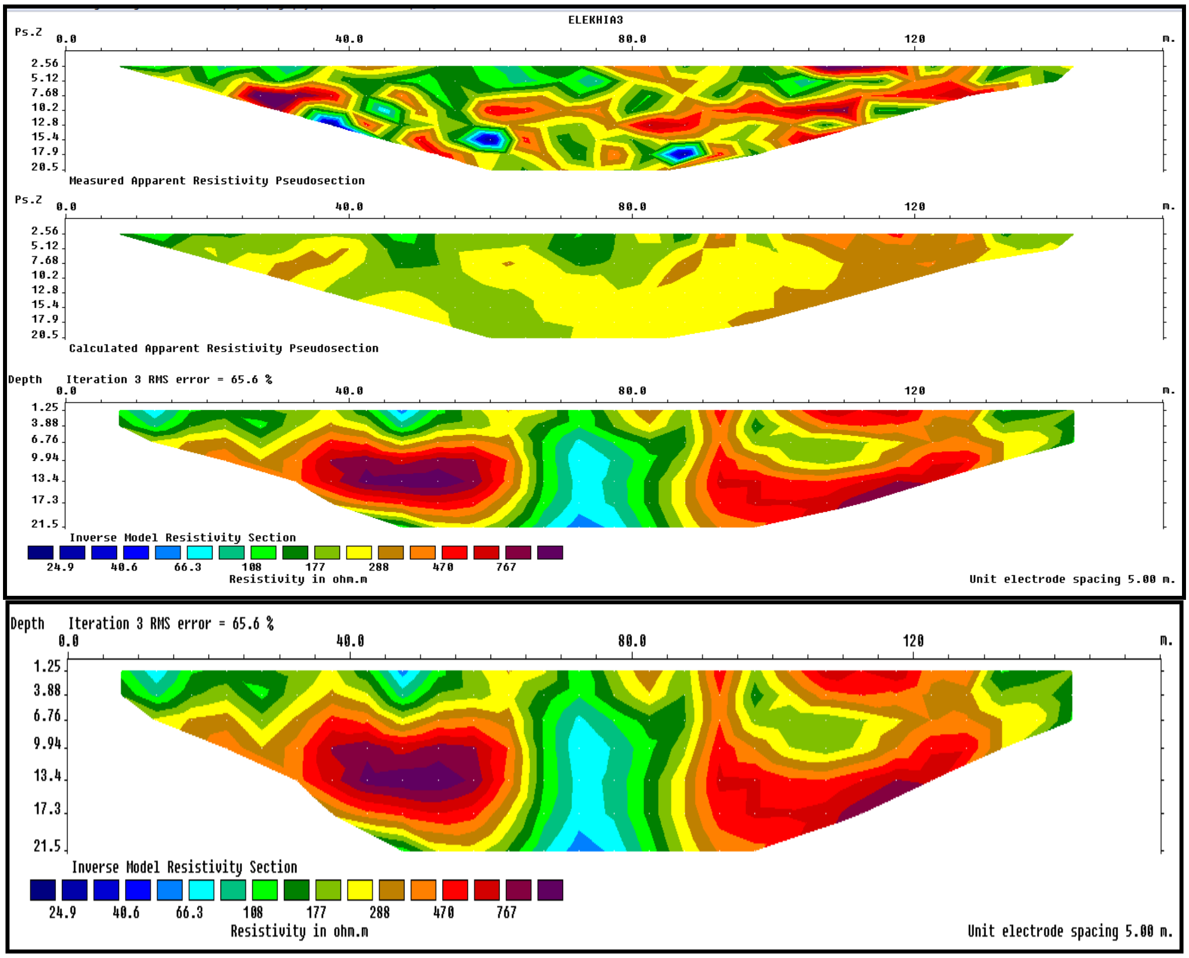


Figure16: Horizontal Resistivity Profiling 4 (NUMBER OF PLUMES)

IV. ORGANOLYPTIC TEST

Organolyptic test was carried out to find out the field base physical parameters of the existing borehole (hydraulic head) in the workshop. It was found that the water from the borehole has odour, colour and has a taste. This implies that the water is not suitable for consumption.

V. CONCLUSION

Although there are varieties of wastes generated in a workshop, the automobile wastes studied in this work are used lubricating oil, contaminated petrol and diesel, used grease, acid and calcium carbide. The method of data collection was primary because it has never been collected and analysed by someone. These data was used to determine the possible depth of automobile wastes penetration and the thickness of the contaminated area for each profile line in the automobile workshop. Analysis of possible depth of automobile wastes penetration indicate that profile line 4 (Vertical Electrical Sounding 1) has the highest depth of automobile wastes penetration which is about 60m while profile line 3 (Vertical Electrical Sounding 3) has the least depth of automobile wastes penetration which is about 0.4m. Also profile line 2 has the highest number of plumes while profile line 4 has the least number of plumes. The number of plumes for horizontal resistivity profiling 1, 2, 3 and 4 are 3, 5, 3 and 2 respectively. Furthermore, profile line 3 has the highest thickness of the contaminated area which is about 14m while profile line 4 has the least thickness of contaminated area which is about 5m. Such information could serve as a starting point for future assessment of automobile wastes, when allocating site to automobile workshop.

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