SUBSURFACE DETERMINATION OF CONTAMINANTS USING ELECTRICAL RESISTIVITY METHOD SCHLUMBERGER ARRAY VES

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Abstract

*Electrical resistivity of soil can be considered as a proxy for a spatial and temporal variability of many other soil physical properties (i.e. structure water content or fluid composition). Because the method is non-destructive and very sensitive it offers a very attractive tool for describing the substance properties without digging. It has been already applied in various contexts like ground water exploration, land fill and solute transfer delineation, agronomical management by identifying areas of excessive compaction of soil horizon thickness and bed rock depth and at least assessing the soil hydrological properties. The research took place at Magasawa Madobi local government area, Kano state. Ip2win was used for interpreting the results and it is capable of solving resistivity electrical prospecting Ip forward and inverse problem for a variety of commonly used arrays for the cross section with a resistivity contrast within the range of 0.0001 to 10000. Vertical Electrical Sounding (VES) point 1 has about 4 layers; the first layer (**layer 1**) has the resistivity of 38.1Ωm, the thickness of 03.375m and the depth of 0.375m.* ***Layer 2*** *has the resistivity of 313Ωm, the thickness (height) of 1.19m and the depth of 1.57m.* ***Layer 3*** *has the resistivity of 19010Ωm, the thickness (height) of 0.934m and the depth of 2.5m.* ***Layer 4*** *has the resistivity of 19010Ωm, the thickness (height) of 3.96m and the depth of 6.46m. From our investigation, we observe that the soil of Magasawa town has different resistivity which indicates the presence of different materials.*

Keywords: Resistivity, Contaminations, Vertical Electrical Sounding (VES).

1.0 INTRODUCTION

Contamination of groundwater can take place either from a wider source like percolation from agricultural fields on account of the application of fertilizers and pesticides, or from a point source like waste disposal sites, tanneries etc. So, sources for water contamination can be natural, industrial, mining, municipal waste and radioactive waste disposals (Gebru et al, 2012). One of the challenging issues facing mankind at this juncture is that of pollution of freshwater by various anthropogenic activities (Gaikwad et al, 2014).

The purpose of electrical surveys is to determine the subsurface resistivity distribution by making measurements on the ground surface. From these measurements, the true resistivity of the subsurface can be estimated (William, L., 2007). The ground resistivity is related to various geological parameters such as the mineral and fluid content, porosity and degree of water saturation in the rock (Eminike, E., 2001).

2.1 THEORY OF THE ELECTRICAL RESISTIVITY METHOD

The fundamental physical law used in resistivity surveys is Ohm's Law that governs the flow of current in the ground. The equation of Ohm's Law in vector form for current flow in a continuous medium is given by

$$V = IR \qquad (1.1)$$

Where V = Potential, I = Current and R = Resistance.
The common types of electrode array that are most commonly used are Schlumberger, Wenner and Dipole-dipole.

2.2 SCHLUMBERGER ARRAY

Schlumberger array has always been the favored array in Africa, until recently, the winner array was used more extensively than the schlumberger array in the United state (Telford, M.W., et al, 1990). In a survey with varying electrode spacing, field operation with the schlumberger array are faster, because all four electrode are of the wenner array are moved successive observation, but with the Schlumberger array, only the outer ones need to be moved (Reynolds, J.M., 1997). The Schlumberger array also is said to be superior indistinguishing lateral from vertical variation insensitivity. On the other hand, the wenner array demands the less instrument sensitivity, and reduction of data is marginally easier (Anudu, G., et al, 2008).

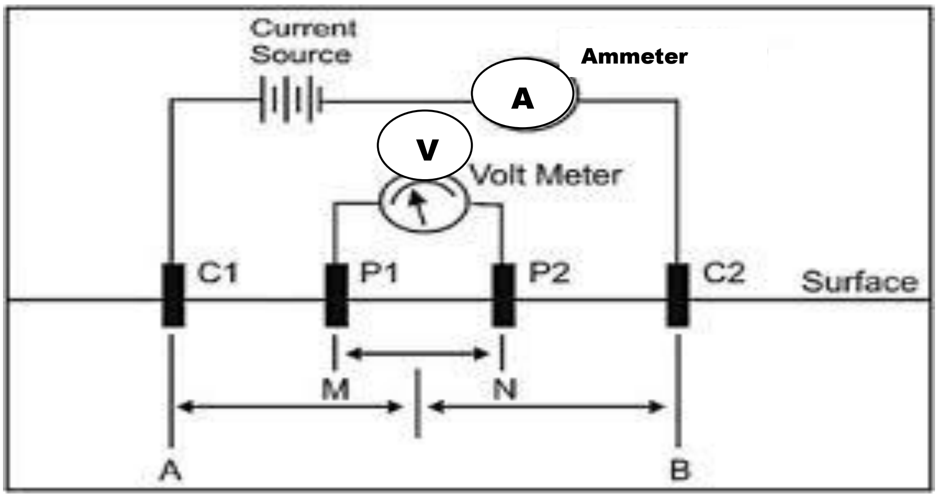

Figure 2.1: Schlumberger array Electrode array configuration

3.1 FIELD WORK PROCEDURE

Four electrodes were put into the ground by using hammer. The outer electrode C_1 and C_2 are current, while the inner electrode P_1 and P_2 are potential. The distance between each electrode is 0.5m. The current electrode C_1 was connected directly to the battery then to Multimeter. The current electrode C_2 was connected first to the Multimeter then to battery. The potential electrode P_1 and P_2 were connected directly to the multimeter. The current at that place was read and potential due to such current was recorded. The current electrodes were moved by 0.5m until 10m was reached. Keeping the distance between the potential electrodes constant, appropriate reading was taken at each movement. The procedure was repeated by 1m distance between each electrode until 20m was reached. The readings were arranged in the table of values and the appropriate resistivity was calculated.

3.2 DATA REDUCTION

AB/2	Mn/2(m)	V (v)	I(A)	K=P/R(m)	R=V/I (Ω)	P(Ω m)
0.75	0.5	0.3	0.02	3.1416	15	47.124
1.25	0.5	0.7	0.04	9.4248	17.5	164.93

AB/2 **=** the distance between two outer electrode (Current).
MN/2 = the distance between the two inner electrode (Voltage).
V(v) = the value obtained by using multimeter (Voltage).
I(A) **=** the value obtained by using Multimeter (Current).
K =ρ/R (m) = K-factor. R=V/I = Resistance. ρ (m) = Resistivity.

4.1 INTERPRETATION OF THE RESULTS

The table presents the names of the locations, the coordinates of the locations in terms of latitudes and longitudes, the electrode separation, the K factor, the VES points, as well as the interpreted water level in the surveyed location.

SCHLUMBERGER ELECTRODE CONFIGURATION
LOCATION: MAGASAWA, MADOBI L.G.A
COORDINATE: 11.888°N 8.50217°E STATE: KANO
AB/2

AB/2	MN/2(m)	V(V)	I(A)	K= ρ/R (m)	R=V/I (Ω)	ρ (Ωm)
0.75	0.5	0.3	0.02	3.1416	15	47.124
1.25	0.5	0.7	0.04	9.4248	17.5	164.93
1.5	0.5	0.1	0.1	13.744	1	13.744
1.75	0.5	0.3	0.01	18.85	30	565.49
2.25	0.5	0.2	0.1	31.416	2	62.832
2.5	0.5	0.2	0.01	38.877	20	777.54
2.75	0.5	0.2	0.2	47.124	1	47.124
3.25	0.5	0.1	0.1	65.973	1	65.973
3.25	0.5	0.2	0.1	65.973	2	153.15
3.5	0.5	0.1	0.1	76.576	1	87.965
3.75	1	0.2	0.01	55.96	20	1119
4.25	1	0.01	0.01	62.832	1	62.832
4.5	1	0.2	0.2	70.097	1	70.097
4.75	1	0.1	0.1	85.805	1	85.805
5.25	1	0.2	0.01	94.248	20	1885
5.5	1	0.02	0.1	131.95	0.2	26.389
6.5	1	0.1	0.1	175.93	1	175.93
7.5	1	0.02	0.01	226.19	2	452.39
8.5	1	0.2	0.02	282.74	10	2827
9.5	1	0.4	0.04	345.58	10	3456

Table 4.1: Data obtained at Magasawa of Madobi L.G.A Kano.

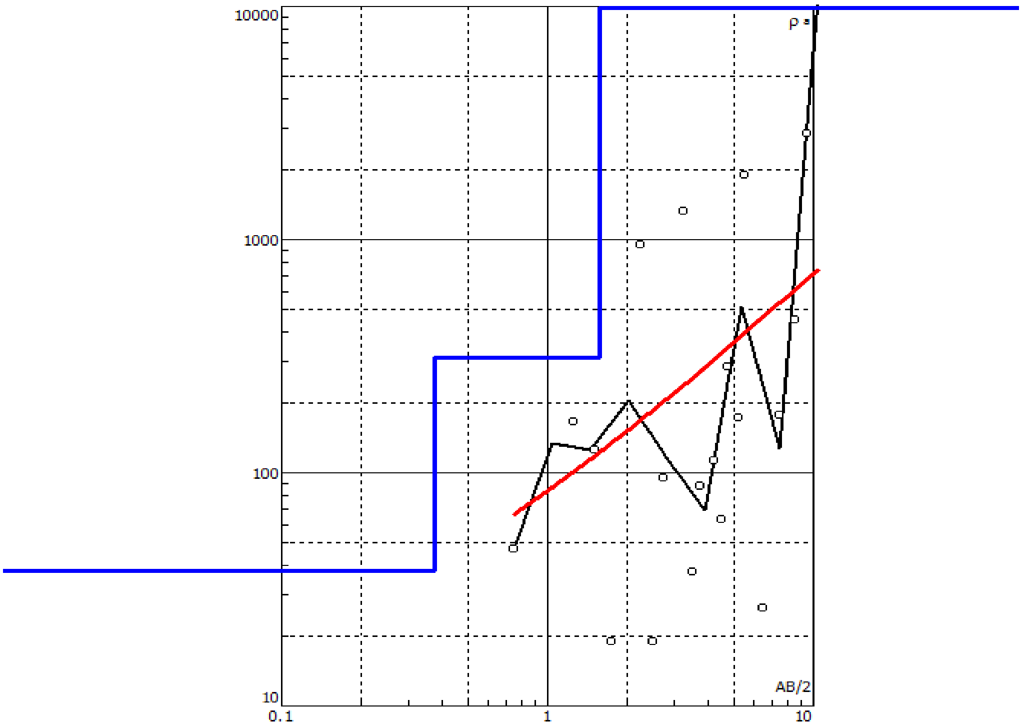

Figure 4.2: The graph of Resistivity against depth data taken from VES point.

4.2 AUTOMATED INTERPRETATION OF THE RESULT

The concept of the profiling interpreting is the foundation of Ip2win. It imposes that data for a profile are treated as a century representing the geological structure of the survey area as a whole rather than a set of independent objects dealt separately. The concept implemented mainly by using interactive semi – interactive mode rather than automated interpreting model (Zond Geophysics Software, 2001-2012).

Ip2win is capable of solving resistivity electrical prospecting Ip forward and inverse problem for a variety of commonly used arrays for the cross section with a resistivity contrast within the range of 0.0001 to 10000.

4.3 DISCUSSION

VES point 1 has four (4) layers; the first layer (**layer 1**) has the resistivity of 38.1Ωm, the thickness of 03.375m and the depth of 0.375m. **Layer 2** has the resistivity of 313Ωm, the thickness (height) of 1.19m and the depth of 1.57m. **Layer 3** has the resistivity of 19010Ωm, the thickness (height) of 0.934m and the depth of 2.5m. **Layer 4** has the resistivity of 19010Ωm, the thickness (height) of 3.96m and the depth of 6.46m. The areas of low resistivity show the presence of contaminations.

4.4 CONCLUSION

Vertical Electrical Sounding (VES) point 1 has about 4 layers; the first layer (**layer 1**) has the resistivity of 38.1Ωm, with the thickness of 03.375m and the depth of 0.375m. **Layer 2** has the resistivity of 313Ωm, with the thickness (height) of 1.19m and the depth of 1.57m. **Layer 3** has the resistivity of 19010Ωm, with the thickness (height) of 0.934m and the depth of 2.5m. **Layer 4** has the resistivity of 19010Ωm, with the thickness (height) of 3.96m and the depth of 6.46m. From our investigations, we observed that the soil of Magasawa town has different resistivities which indicate the presence of different materials.

5.0 RECOMMENDATION

We recommend further geophysical investigation using different geoelectric method in order to accurately design and specify the kind of different materials present in the area, due to pollutant flowing from Challawa Industries.

References:

Anudu, G., Onwuemesi, A., Ajegwu, N., Onuba, L., & Omali, A. (2008). Electrical Resistivity Investigation For Groundwater In The Basement Complex Terrain. A Case Study Of Idi-Ayunre And Its Environs, Oyo State Southern Nigeria. *Natural And Applied Sciences Journal* , 183-193.

Eminike, E. (2001). Geophysical Exploration For Grounwater In Sedimentary Environment, A Case Study From Nnaka Over Nnaka Formation In Anambra Basin, South Eastern Nigeria. *Global Journal Of Pure And Applied Sciences* , 1-12.

Gaikwad, G. L., Wate, S. R., Ramteke, D. S., & Roychoudhury, K. (2014). Development Of Microbial Consortia For The Effective Treatment Of Complex Wastwater. *Journal Of Bioremediation And Biodegradation* , 6.

Gebru, H., Tadesse, N., & Konka, B. (2012). Impact Of Waste Disposal From Tannery On Surface And Groundwater, Sheba Leather Factory Near Wukro, Tigray, Northern Ethiopia. *International Journal Of Earth Sciences And Engineering* , 665-672.

Reynolds, J. M. (1997). *An Introduction To Applied And Enviromental Geophysics.* England: John Wiley & Sons Ltd.

Telford, M. W., Geldart, L. P., & Sheriff, R. E. (1990). *Applied Geophysics, Second Edition.* Cambridge: Cambridge University Press.

William, L. (2007). *Fundamental Of Geophysics, Second Edition.* Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo: Cambridge University Press.

Zond Geophysical Software. (2001 -2012). *Program For Two-Dimensional Interpretation Of Data Obtained By Resistivity And Induced Polarization Methods (Land, Borehole And Marine Variants).* Saint-Petersburg.