Environmental Pollution Potential of Dumpsite Using Very Low Frequency (VLF) Electromagnetic Method.

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ABSTRACT

As a result of human activities, waste products are generated as a matter of necessity. Attempts at waste disposal give rise to landfills, and dumpsites, among other methods. These can contain undesirable materials such as metals and toxic chemicals that can cause pollution of air, soil, and water. In this study, very low frequency electromagnetic (VLF) method was used to map the contamination plumes, and detect the seepage path at the Ibusa-Road dumpsite in Asaba, Delta State of Nigeria. The geographical position was determined and VLF readings were taken in three traverses using the WADI (VLF) system manufactured by ABEM. The data obtained were plotted and the interpretation showed some significant conductive zones associated with contamination plumes.

(Keywords: pollution, contamination plumes, seepage, Delta State, Nigeria, VLF)

INTRODUCTION

The Earth as we know it today has been altered or changed from its original state due to human interaction with the environment orchestrated by the demands of life's activities. The environment - our surroundings, or according to PageWise Inc. (2008), the place where you live, becomes polluted as a result, of these activities (industrial, business and domestic, exploration of minerals, agriculture etc.).

Pollution is the contamination of air, soil, and water by chemical substances that are harmful to human health and the environment (Madrid 2008, Page Wise Inc. 2008).

There are different types of pollution including noise, air, water, and land pollution.

Noise: is sound of irregular frequencies or unpleasant sound. When noise is present in "uncomfortable" sound levels, it amounts to noise pollution. Noise pollution affects not only speech comprehension (Ross 2007), it can cause disturbance, stress, loss of hearing, and sleep disturbance among other health effects.

Air Pollution: is the introduction into the atmosphere of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms or damage to the environment (Marriama Webster Online Dictionary). Air pollution can cause death and illness (American Heart Organization, 2008; PageWise 2008). In addition, destruction of the ozone layer is predicted to increase skin cancers and cataracts, as well as damage to certain crops, etc.

Soil Pollution: is the introduction of harmful chemicals and toxic waste into the soil. According to PageWise, Inc. (2008), dumping of waste in many areas is a major cause of soil pollution. When soil in and near production areas becomes contaminated due to improper disposal of waste material, such land cannot be used for agricultural operations (Pagewise Inc. 2008). Landfills and other waste dumps can cause local leachates and seriously affect wells and drill holes used for public water supplies.

Water Pollution: is an area that is of serious concern, especially as at it affects groundwater, (Zezhong, 1993; Lee, 1996; PageWise Inc., 2008; Ofehe, 2008; Groundwater Foundation, 2008; Michigan DEQ, 2005). Water becomes polluted or contaminated when leachates from

dumpsites percolate into the aquifer (Zezhong 1993).

This paper investigates the pollution potential of a dumpsite situated along Ibusa-Road Asaba, using the Very Low Frequency (VLF) Electromagnetic Induction method. Human activities are a necessity; and a consequence of these activities is the generation of waste which must be taken care of in waste disposal sites/dumpsites, landfills or by burning.

According to Charolette (1998) and White (1995), despite the attempt at waste avoidance, reduction, reuse, and recovery, landfill and waste disposal sites are still the principal focus for ultimate disposal of residual waste and incineration residue world-wide.

Dumpsites, apart from the fact that they destroy the aesthetic value of the environment, can contaminate the soil, as well as groundwater. Dumpsite constituents include toxic wastes, domestic or household materials, metal residues, paints, etc. They have the effect of weakening the geologic sections underlying the waste thereby providing seepage paths for the leachate from the dumpsite to percolate into underground water and rendering it unfit for human consumption.

Studies (Adepelumi, et al., 2005; Kaya, et al., 2007; and www.geo.ute.edu, 2008) have been used successfully to delineate contamination plumes in different parts of the country (Nigeria) and in some parts of the world.

The VLF Electromagnetic Induction method used in this work is one of the many electromagnetic methods used in geophysical surveys. Depending on the operational mode of the source, we have three main categories; the continuous wave field method (frequency domain); Transient field method (time domain), and magnetotelluric methods. The VLF belongs to the continuous wave field method and is essentially an orientation measuring receiver using waves or energy from a pre-existing and powerful transmitter station operating at frequency range of 15 30kz.

In terms of radio terminology, these frequencies are low but may not be low in the context of geophysical methods, where frequencies down to 100Hz are used (Beck, 1981; www.geo.utep.edu, 2008).

METHOD

The WADI instrument used in the measurements utilizes the magnetic components of the electromagnetic field generated by military radio transmitters that use the VLF frequency band. Electrically conductive structures on the surface or underground affect locally the direction and strength of the field generated by the radio signals. Consequently a weak secondary field(S) builds up around the structure. The combination of primary (P) and secondary (S) gives a resultant (R) which is measured by the receiver.

The ratio of the amplitude of the Real (Re) and Imaginary (Im) components of the secondary field is related to the phase angle. The greater the Re/Im ratio, the better is the conductor or structure.

In the field procedure, the frequency of a station is selected and the current input recorded. The instrument is tilted around until a good signal is obtained and the tilt of the coil recorded. This gives the ratio of Re to Im.

The WADI instrument is fitted with a software which automatically gives a filter real (FRe) and Imaginary (Flm) components. The VLF readings are plotted manually or by using computer software and the graphs interpreted. The characteristics of the graph can give (i) the location of the conductor, below the inflection point (ii) a qualitative measure of the depth to the top of the conductor using the slope of the graph (www.goe-utep, 2008).

LOCATION

This study was carried out in Asaba in Oshimili S. Local Government Area of Delta State. The Dumpsite is located at Lat E.06043'9.7" and Long N060 II' 53'.7" along Ibusa Road in Asaba (Figure 1).

RESULTS, ANALYSIS, AND INTERPRETATION

VLF data were collected along three traverses at the study site. Data collected were recorded on ABEM WADI survey field data sheet that shows the following:

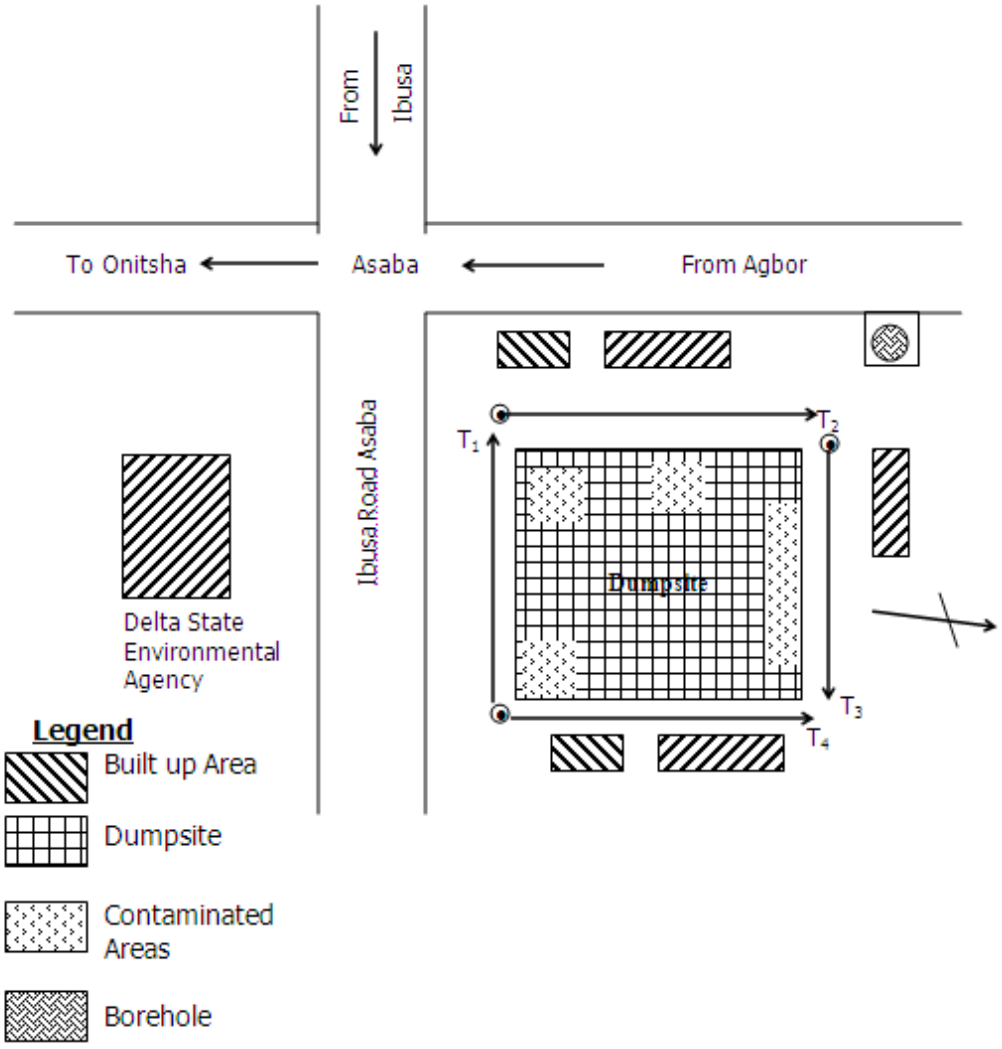

Figure 1: Base Map of Ibusa Road Dumpsite (Not drawn to scale).

(i) Current Strength
(ii) Raw Real (RR)
(iii) Filter Real (FR)
(iv) Raw Imaginary (RI)
(v) Filter Imaginary (FI) (Table 1)

Graphs of RR versus position (m) and FR versus position (m) were plotted for each traverse (Figure 2). The interpretation of the graphs shows the following:

(a) Traverse (i): Two high positive peaks were observed between 0 – 20m and between 20 - 48m. These high positive peaks, correspond to regions of high conductivities characterized by contaminants or weak zones. The lateral spread is approximately 8m and 30m, respectively.

(b) Traverse (2): A positive peak of relatively small value is observed between 25 - 40m. This peak indicates the presence of contamination that speeds up to 10m

(c) Traverse (3): A very high positive peak is observed along this traverse between the distance of 35 to 56m, with a lateral spread of about 11m and small peak between 10 - 20m. As stated earlier, these are weak zones prone to contamination.

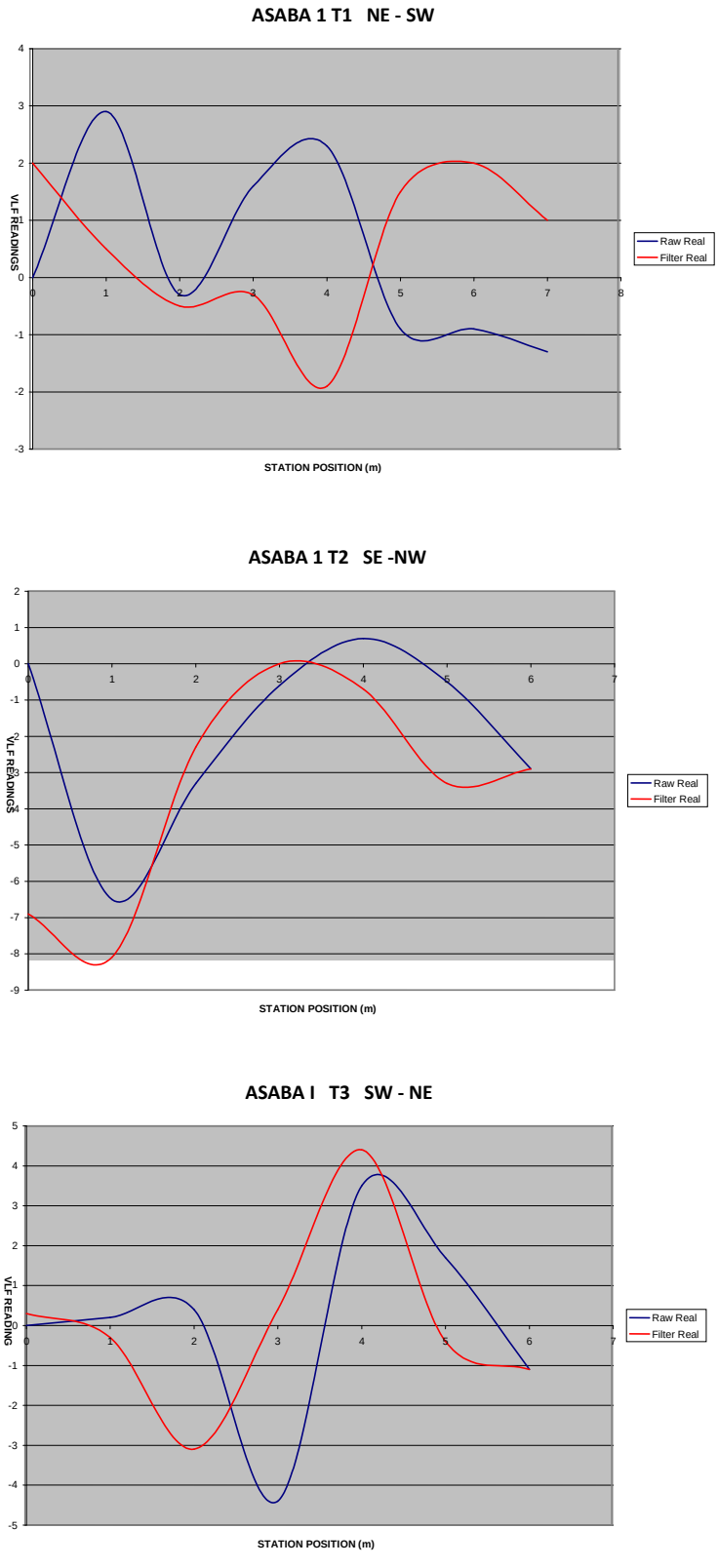

Figure 2: RR versus Position (m) and FR versus Position (m).

ABEM WADI SURVEY FILED DATA SHEET

Site Location: Ibusa Road Asaba
Current Strength: 16
L.G.A.: Oshimili
Frequency: 27.2KHz
State: Delta
Profile Interval: 18m
Weather Condition: Bright/Fine
Btw, Reading Pt: 10m

Operator: Onwuka, F.
Azimuth: NE SW (0006/0000)T_1
SE NW (0007/0000)T_2
SW NE (0008/000)T_3
Recorder: Onwuka, F.O.
Date: 25-7-08
Survey Purpose: Research
Location of Borehole: 60m from dumpsite

Table 1: Field Data.

P/N	READING		REMARKS	
T_1	RR	FR	RI	FI
0	0.0	2.0	16.8	2.7
1	2.9	0.5	8.7	2.2
2	-0.3	-0.5	16.6	1.6
3	1.6	-0.3	10.4	3.4
4	2.3	-1.9	16.9	0.5
5	-0.9	1.5	17.3	-1.9
6	-0.9	2.0	12.2	-1.7
7	-1.3	1.0	10.0	-1.3

T_2	RR	FR	RI	FI
0	0.0	-6.9	4.1	-27
1	06.5	-8.1	12.2	-3.1
2	3.3	-2.3	12.7	-6.1
3	-0.6	0.0	16.0	-0.4
4	0.7	-0.7	12.2	0.5
5	-0.5	-3.3	12.8	-1.0
6	-2.9	2.9	15.5	-0.8

P/N	READING		REMARKS	
T_3	RR	FR	RI	FI
0	0.0	0.3	9.2	-0.8
1	0.2	-0.3	9.8	-2.7
2	0.4	-3.1	17.8	-1.6
3	-4.4	0.4	16.2	1.7
4	3.5	4.4	8.9	-0.2
5	1.7	-0.4	15.5	-1.9
6	-1.1	1.1	16.6	-0.5

In conclusion, following the above analysis and interpretation, traverses (I) and (3) indicate the presence of high contaminated zones which can constitute seepage path for groundwater pollution. The contamination plume extends to a distance of about 38m in the NE-SW direction (T_1); about 15m in the SE-NW direction (T_2) and about 11 m in the SW-NE direction (T_3); 11m in the SE - NW direction (T_3).

RECOMMENDATION

The VLF method has been used to delineate the contamination plume in this study. It is recommended that other geophysical methods be employed in addition, to confirm the results of this study. In addition, water samples should be taken for analysis, to establish whether or not the groundwater has been polluted by leachates from the dumpsite.

REFERENCES

1. ABEM. 2008. *Instruction Manual.* S -16\ 02. ABEM: Bromma, Sweden. http://www.abem.se/
2. Adepelumi, A.A., Ako, B.D., and Ajayi, R.R. 2001. "Groundwater Contamination in the Basement Complex Area of Ile-Ife, Southern Nigeria: A Case Study Using the Electrical-Resistively Geophysical Method". *Hydrogeology*. 6.
3. American Heart Association. 2008. Dallas, TX. http://www.heart.org
4. Beck, A.E. 1981. *Physical Principles of Exploration Methods*. Macmillan Press: London, UK.

5. Charlotte, Y. 1998. “Applying COSHH Principles of Waste Management”. *Environmental Health Journal*. 106(10).

6. The Groundwater Foundation. 2008. Lincoln, NE. http://www.groundwater.org

7. Kaya, A.M., Guicin Ozurlan, and Ebru, S. 2007. *Delineation of Soil and Groundwater Contamination using Geophysical Methods at a Waste Disposal site in Canakkale, Turkey*. Springer: Amsterdam, Netherlands.

8. Lee, G.F. and Jones-Lee, A. 1996. “Evaluation of the Potential for a Proposed or Existing landfill to Pollute Groundwater”. Fred Lee & Assoc.: Elmacero, CA.

9. Madrid Visca. 2008. *Pollution (Problem and Solution) Biog*. Archive.

10. Merriam-Webster. 2010. Online Dictionary. http://www.merriam-webster.com

11. Michigan DEQ. 2003. “Preventing Groundwater Contamination”. Department of Environmental Quality (DEQ), Environmental, Assistance Center: Lansing MI.

12. Ofohe, S. 2008. “Environmental Pollution” http://www.nigerdeltacampign.com.

13. PageWise, Inc. 2008. “Pollution Problem”. Assortment. Com: Austin, TX.

14. Ross, M. 2007. *Hearing Loss Magazine*. www.hearingnresearch.org/Dr Ross/ANL.

15. Universidad de Piura. 2008. “Electromagnetic Survey”. www.Geo.UtepEdu/Pub/Ortega/Meg1/Meg1/Htm1.

16. White, R. 1995. *Household Waste Recycling*. Earth Sean Pub.:London. UK. 174.

17. Zezhong Z. 1993. “Industrial Waste Geotechnical Engineering”. In: Fell R, Phillips, I, and Garrand, C. (eds.). *Proceedings of Geotechnical Management of Waste and Contamination Conference*. Sydney, Australia. 50-512.

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