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EFFECTS OF VERY LOW FREQUENCY ELECTROMAGNETIC METHOD (VLF-EM) AND PHYSICOCHEMICAL CHANGE OF ZANGO ABATTOIR

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ABSTRACT
The study examined the impact of livestock dung on ground water status in the study area. To achieve this, a very low frequency EM survey was conducted; the aim and objective was to detect fractures in the subsurface. VLF data were acquired at 5m intervals along two profiles, with maximum length of 60m in the North-South direction. The fraser filtered real component of the processed VLF data detected anomalous zones/ litho logical boundaries that may possibly serve as conduit for the movement of solid waste contaminant into the ground water. Water sample from the hand dug wells were collected in prewashed 250ml plastic container and analyzed in the Laboratory. Result obtained shows that physicochemical analysis deviate from WHO and SON standard and complement with VLF EM survey. This has shown that it is not free from certain heavy metals, as such, the water is not suitable for human and livestock consumption. It is recommended that the ground water in Zango should be treated using coagulants before use.
Keywords: Abattoir, Livestock, SON, Water quality, WHO, Zango

1.0 INTRODUCTION

Water is one of the nature's most important gift to humanity and all living things. The important of this gift of nature is such that without it man hardly exists as noted by (Maguvu and Mutengu, 2008).

Health officials also emphasized the importance of drinking at least eight glasses of clean water every day to maintain good health (WHO 1985). Adequate water supply to any community is therefore, crucial and determining factor indicating the health condition of such community (WHO, 1985).

Ground water development increased significantly during the second half of the last century in most semiarid and arid areas of the world. This development have mainly been undertaken by a large number of small (private or public) developers and often the scientific or technological know control of this development by the responsible water administration has been scarce (Llamas, 2004; Ugya *et al.,* 2015).

Residents of Kaduna South Local Government Area rely heavily on ground water for domestic use, where over eighty percent (80%) of the populace in the local government area use tube wells or bore holes as water sources (Kaduna State Media Corporation 'KSMC' 09/10/2012). Even in areas where pipe borne water is accessible, wells are used as a complimentary source of water.

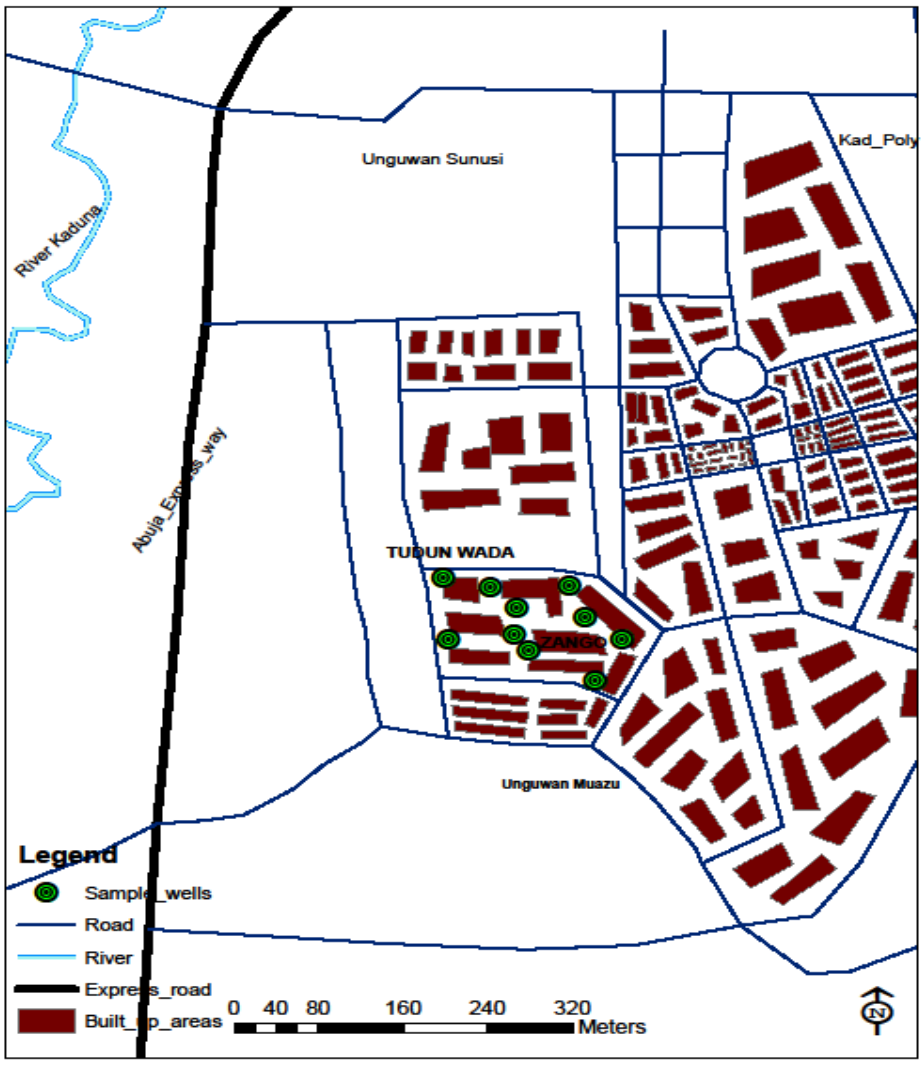
The use of water is restrained by its quality which makes it unhealthy for a particular use, thus, water quality depends on the physical, chemical and biological composition of water, an understanding of the physico-chemical, as well as biological composition of water will enhance the detection of future deviation in water quality (Eze and Madumere, 2012).

In Zango (study area) Tudun Wada, Kaduna South, Kaduna State, pollution arises from inappropriate disposal of animal waste (dung), lack of good manufacturing practices (GMP) and lack of good hygiene practices (GHP). As such livestock dung piled up and waste water containing blood and dung are discharged into the nearby wells, rivers, and streams without treatment, which could lead to pollution of Ground water in the study area. This research thereby aimed at assessing the effect of Very Low Electromagnetic Method (VLF-EM) and Physicochemical changes of Zango ground water.

MATERIALS AND METHODS

Study Area

The study area is Zango, Tudun Wada, Kaduna South, Kaduna state (figure 1). It is located with coordinates, latitude $10^0 30' 104''$ N, and longitude $007^0 24' 452''$ E in the national grid. The study area is both accessible by road and foot, covering 104.5028km^2(Mamman, 1992).



Source: Kaduna state ministry of Land and Survey 2014.

MAP OF THE STUDY AREA SHOWING THE SAMPLE WELLS

Methodology

Very low frequency-electromagnetic method (VLF-EM) was applied along two (2) profiles in the Zango, Tudun Wada, Kaduna South, Kaduna state.

Water from eleven (A_1,A_2,A_3,A_4,A_5,A_6,A_7,A_8,A_9,A_{10},A_{11}) wells in Zango, Were collected at a different depth (table 1), and stored in plastic container. The Laboratory Analysis was performed for the sample in the containers.

Data Collection (VLF-EM)

VLF-EM data were collected along two (2) profiles and measurements were made with a station separation of 5 m using the ScintrexEnvi meter in the VLF-EM mode (i.e. measuring the ratio of the polarized magnetic field) according to Fraser, (1996), Telford *et al.*, (1990) and Ahzegbobor, (2010).

Sampling Procedure and Sample Collection

Primary and Secondary sources of data were employed in the research. For primary data, the water samples were labeled (As mention above), and categorize into three: the Residential Area (A_1, A_2, and A_3), the Abattoir Area (A_4, A_5, A_6, A_7, and A_8), and the Cow Residue Area (A_9, A_{10}, and A_{11}). All sample obtained were confined to wells for house and domestic purpose (Abdullahi and Osazuwa, 2011).

Table 1: Wells (sample) coordinates (Longitude, Latitude, and Elevation).

s/no	Sample	Area	Latitude	Longitude	Elevation
1	A_1	Residential Area	$N10^030'104"$	$E007^024'452"$	582.40
2	A_2		$N10^030'103"$	$E007^024'452"$	566.70
3	A_3		$N10^030'163"$	$E007^024'505"$	587.80
4	A_4	Abattoir Area	$N10^030'116"$	$E007^024'562"$	628.30
5	A_5		$N10^030'150"$	$E007^024'624"$	585.10
6	A_6		$N10^030'180"$	$E007^024'589"$	595.50
7	A_7		$N10^030'194"$	$E007^024'601"$	589.30
8	A_8		$N10^030'256"$	$E007^024'548"$	590.20
9	A_9	Cow Residue Area	$N10^030'256"$	$E007024'559"$	599.60
10	A_{10}		$N10^030'244"$	$E007^024'589"$	588.30
11	A_{11}		$N10^030'265"$	$E007^024'536"$	596.40

Table 2:Depth of the wells (sample).

S/no	Sample Wells	Area	Depth to water level(inch)	Depth to water level(m)	Depth of static water level(inch)	Depthof static water level(m)	Total depth (inch)	Total depth(m)
1	A_1	Residential	64.00	1.60	18.00	0.50	82.00	2.10
2	A_2	Area	67.50	1.70	39.50	1.00	107.00	2.70
3	A_3		86.50	2.20	20.00	0.50	106.50	2.70
4	A_4	Abattoir	126.00	3.20	48.00	1.20	174.00	4.40
5	A_5	Area	133.00	3.40	17.00	0.40	150.00	3.80
6	A_6		131.00	3.30	7.60	0.20	138.60	3.50
7	A_7		149.00	3.80	4.00	0.10	153.00	3.90
8	A_8	Cow	106.00	2.70	46.00	1.20	152.00	3.90
9	A_9		177.00	4.50	10.00	0.40	187.00	4.90
10	A_{10}	Residue	99.00	2.50	56.50	1.40	155.50	3.90
11	A_{11}	Area	73.50	1.90	200.00	5.10	273.50	7.00

The measurement of depth of well above was done by using fifty meter (50m) measuring tape, seven kilogram (7kg) weight, and a long rope, the seven kilogram weight was tied to one end of the rope and gently immersed into the well, until zero tension was observed on the rope (string), meaning the rope weight had reached the bottom of the well. The distance from the weight to the wet region on the rope is measured by fifty meter tape as depth of static water level, and distance from wet region on the rope to brim is measured as depth to water level, and total depth of well is the summation of depth of static water level with depth to water level(Garber and Koopman, 1968; William, 2001).

Physico-chemical and Heavy Metals Determination

After selection sampling of the identified wells was done. The water sample were collected and poured into sterilized (with Tetraoxosulphate (VI) acid (H_2SO_4)) plastic container of capacity of two (2) liters and taken to the laboratory within time frame of four and half hours (4hrs 30mins), to prevent deterioration. The collected water sample were analyzes and the following parameter: Bio-chemical Oxygen Demand (B.O.D), Chemical Oxygen Demand (C.O.D), pH, Cadmium (Cd), Zinc (Zn), Iron (Fe), Copper (Au), Lead (Pb), Chromium (Cr), and electric conductivity (EC) were determined according to APHA, (2005).

Statistical Analysis

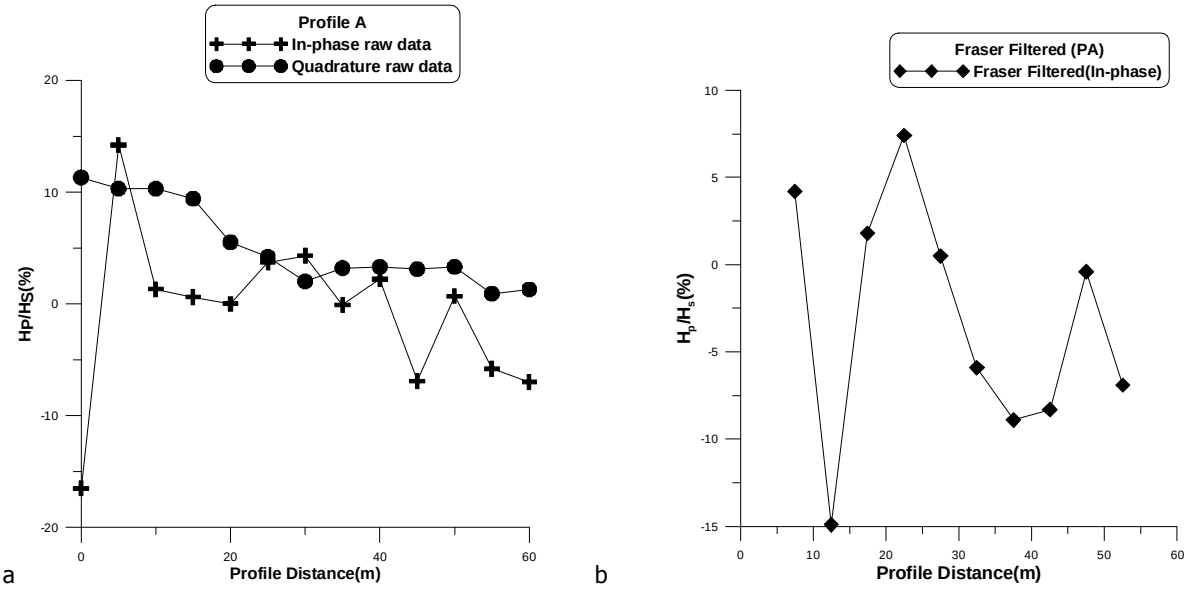
Data were analyzed using graphical method, and descriptive statistics. Comparison was made between the categories of samples obtained with the Standard Organization of Nigeria (SON), and World Health Organization (WHO) and was achieved using sample statistics, i.e mean and standard deviation.

RESULTS AND DISCUSSION

Geophysical Interpretation of VLF Result

Interpretationof Profile A

Figure 2 (a) shows the VLF profile data (in-phase and Imaginary) along traverse A. The figure shows that the imaginary (Imaginary) components are positive with values ranging from +0.9% to +11.3%. The real component contains both positive and negative values. The patterns of the VLF profile are suggestive of shallow conductive structure underlying this traverse (Adepelumi *et al.,* 2005). The real data was then subjected to filtering using Fraser filter, Figure 2 (b). The real data became enhance and more definitive after the filtering process. The Fraser-filtered data (in-phase) have high positive peak response at position 25m and is almost symmetrical; this is an indication of anomalous body of large dimension and steeply dipping source (Nasir and Osazuwa, 2011).

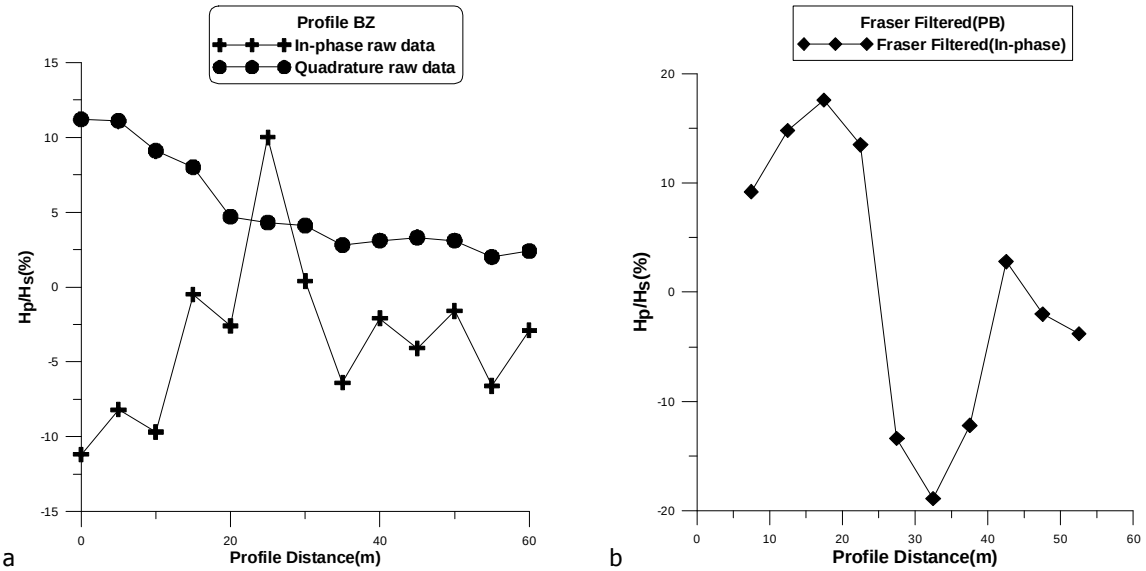


a b

Fig 2 Traverse A: (a) Unfiltered Real and Imaginary data (b) Fraser Filtered (Real) data.

Interpretation of Profile B

Fig 3 (a) Shows the unfiltered data (Real and Imaginary) obtained along traverse B. Same pattern obtained along profile A was repeated along this profile i.e. with Imaginary component being positive while the real component contains both negative and positive values with predominantly negative values. The magnitudes of the unfiltered imaginary measurements are high at western end of the traverse then gradually drop to minimum in the eastern end of the traverse. The magnitude of the real unfiltered data is high and negative at western end of the traverse. Fig 3 (b*)* is the Fraser filtered (Real) data which revealed high positive peak response at profile distance 15m indicative of fractures



a b

Fig 3 Traverse B (a) Unfiltered Real and Imaginary data (b) Fraser Filtered (Real) data.

Chemical Analysisof the Well Water

Table 3: Summary of Test Result on Samples.

Parameter	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
B.O.D (Mg/l)	48.0	350.0	408.0	520.0	446.0	390.0	475.0	512.0	484.0	398.0	460.0
C.O.D (Mg/l)	90.24	658.0	767.0	977.60	838.0	733.2	893.0	962.56	909.9	748.2	864.8
pH (Mg/l)	6.70	6.40	6.40	6.30	6.30	6.00	6.10	6.40	5.80	5.90	6.20
Cadmium (Mg/l)	NIL	0.41	0.01	NIL	NIL	0.001	0.001	NIL	NIL	NIL	NIL
Zinc (Mg/l)	0.01	0.02	0.03	0.03	0.05	0.05	0.06	0.07	0.05	0.08	0.11
Iron (Mg/l)	0.14	0.20	0.35	0.30	0.25	0.32	0.40	0.26	0.31	0.32	0.34
Copper (Mg/l)	0.08	0.12	0.11	0.14	0.14	0.15	0.16	0.11	0.12	0.14	0.16
Lead (Mg/l)	0.01	0.01	0.10	0.10	0.11	0.12	0.14	0.11	0.13	0.13	0.12
Chromium (Mg/l)	0.12	0.33	0.30	0.31	0.41	0.32	0.11	0.16	0.17	0.12	0.14
Conductivity (µs/cm)	1030.0	580.0	1280.0	1510.0	1610.0	590.0	1810.0	1310.0	570.0	580.0	1930.0

Bio-chemical Oxygen Demand (BOD)

The concentration of BOD ranges from 48.00mg/l to 520mg/l. The result shows that, Residential Area (control) has the minimum mean (Average) of 268.67mg/l, and highest standard deviation of 157.82mg/l, due to lack of constant dumping of dung, no direct discharge of organic waste directly into the streams and wells from adjourning abattoir.

The Cow Residue Area have the lowest standard deviation of 36.23mg/l, and highest mean of 447.33mg/l, due to direct discharge of organic waste into the streams and wells. However in Abattoir Area, the sample (well) A_4, have the highest BOD of 520mg/l, which is found at the dumping area of livestock dung. In summary, the closer the sample location point to the dung, the higher the BOD. All the values according to WHO are above the allowable unit of 200 mg/l (WHO, 1999). This high value of BOD shows that there is an abundance of bacteria which in turn will have detrimental effect on Human after consumption (Lenore *et al*., 2005).

Chemical Oxygen Demand (COD)

The result shows that, the Residential Area has the minimum means of 505.08mg/l and maximum standard deviation of 296.69 due to low discharge of livestock waste in the area. Abattoir area has the maximum mean of 808.85mg/l and medium standard deviation of 89.07mg/l due to direct discharge of livestock waste to some sample (wells) in the area. While cow residue area has the middle mean of 840.99mg/l and lowest standard deviation of 68.11mg/l, due to direct discharge of livestock dung to the area.

All these values of COD obtained ranging from 58-977mg/l are above the permissible limit of 50mg/l as specified by the W.H.O (1999). This high value of BOD shows that there is an abundance of organic materials which in turn will have detrimental effect on Human after consumption (Lenore *et al*., 2005).

pH

The mean for pH in the residential area is highest (6.50) and smallest or minimum standard deviation of 0.06 due to lack of exposure to organic waste. The basic standard allowable limit range from 6.5 - 8.5 (WHO, 2003). While Abattoir area has the mean of 6.22 and standard deviation of 0.15, which is partially not standard allowable limit, due to exposure of some sample (wells) to the organic waste.

However in the Cow Residue Area has the mean of 5.97 and standard deviation of 0.17, which is acidic due to permanent exposure to organic waste. The acidic nature of the pH is due to the production of acid by bacteria action (Bhaita, 2011). This signifies that the water is unsafe for drinking.

Conductivity Test

The Nigerian standard drinking water quality for conductivity is 1000µs/cm. From the result, the Residential area (control) has the mean value of 963.33µs/cm and Standard deviation of 289.64, which is within the allowed range for conductivity, while the Abattoir area has a mean value of 1366.00µs/cm and Standard deviation of 420.17, which is out of the permissible level for conductivity and greater than the control area by 402.67µs/cm. However, the Cow Residue Area has the mean value of 1026.67µs/cm and Standard deviation of 638.77, which also outside the maximum permitted level, and the residential area (control) by 63.34µs/cm, due to exposure to livestock dung in the Area. An excess in conductivity of water quality causes no any health impact (Bhaita, 2011).

Heavy Metals

Cadmium (Cd^{2+})

The result obtain shows that residential area which is the control, has the minimum value of cadmium of 0.01, maximum of 0.410, and mean of 0.210 and standard deviation of 0.200, which is greater than the permissible limit of cadmium. Abattoir area has the mean value of 0.001, which is within the permissible limit, while in Cow Residue area, no value was obtained for the cadmium, because of excessive exposure of the Area to livestock waste. Cd^{2+} can readily accumulate and cause toxicity after longtime of exposure (Waalkes *et al.,* 2011).

The presence of Cd^{2+} in the well water could be attributed to the fact that Cd^{2+} can travel long distances from the source. The activities responsible for the presences of cadmium could be the burning of tyre since Wealkes *et al.,* (2011) reported that human activities, such as tobacco smoking, mining, smelting and refining of on-ferrous metals, fossil fuel combustion and incineration of municipal waste lead to the release of Cd^{2+} into the environment.

Zinc (Zn^{2+})

As from the result the control of the residential area with minimum value of 0.01 mg/l and maximum 0.03 mg/l, has a mean value of 0.020 mg/l, and standard deviation of 0.0002. In the Abattoir Area a mean of 0.052 and Standard deviation of 0.0018 were obtained; These show that these values were greater than the sampling point. However in Cow residue area, the mean value is 0.080 and standard deviation is 0.0018, this is greater than the sampling point due to excessive discharge of organic waste in the area.

The Nigeria standard for drinking water maximum permitted level of Zinc is 3.00mg/l (GESAMP, 2001). The entire sample is within the permissible limit, and it does not have health impact (Bhaita, 2011).

Iron (Fe^{2+})

As from the result, the residential area (control), has the mean value of 0.23 mg/l and Standard deviation of 0.088, which is within the permissible level of Iron as such, does not have health impact, while Abattoir Area has the mean value of 0.306 mg/l and Standard deviation of 0.504, which is greater than the sampling point (control) and maximum permissible level, due to contamination in the sample well. However, the Cow Residue Area has the mean value of 0.323 mg/l and Standard deviation of 0.012, which is greater than the maximum permissible value by 0.023 mg/l, due to excessive dumping of the livestock waste in the area as such, has health impact (Bhaita, 2011).

Copper (Cu^{2+})

The Residential Area (control) has the mean value of 0.10 mg/l, and Standard deviation of 0.017, which is within the permissible level. Abattoir Area has the mean value of 0.14 mg/l and Standard deviation of 0.0167, which is greater than the SON standard value, because of indiscriminate disposal of livestock waste in the area. The Cow Residue Area has the mean value of 0.14mg/l, and standard deviation of 0.0163 with a slight difference with Abattoir Area.

Since the value of copper is not within the permissible limit, it may cause gastro intestinal disorder as reported by Fischer, (2011).

Lead (Pb^{2+})

The Residential Area (control) has the mean value of 0.040mg/l, and standard deviation of 0.042. But Nigerian standard for drinking water for lead is 0.01mg/l as maximum permissible level, which is greater than the value for residential area by 0.03 mg/l, but sample A_1 and A_2 are within the limit of 0.01 mg/l, which show that, there is no contamination of lead in the Residential Area. The abattoir area has a mean value of 0.116 mg/l and Standard deviation of 0.014, which is far greater than the maximum permissible level of lead. However, the Cow residue area has a mean value of 0.140 mg/l and Standard deviation of 0.016 which shows that the value is greater than the permissible level. This could be due to direct and in-appropriate disposal of organic waste in the Area. An excess in lead maximum permitted level causes cancer, affect mental development in infants, etc. (Bhaita, 2011).

Chromium (Cr^{2+})

The maximum permitted level for chromium is 0.05 mg/l (GESAMP, 2001). The table of result show that, all three area are contaminated, the Cow Residue Area has the mean value of 0.143 mg/l and Standard deviation of 0.022, and it is least contaminated. The maximum Area contaminated is the Abattoir area having the mean value of 0.262 mg/l and Standard deviation of 0.111. All the sample wells in all three areas have exceeded the maximum permitted level for chromium, and an excess in it causes cancer diseases (FEPA, 1991; Bhaita, 2011).

Conclusion and Recommendation

The results from the filtered real curves show the presence of vertically dipping conductive features which were interpreted to be fracture zones filled with contaminants. The asymmetry of the conductive anomaly indicates a dipping conductive sheet and these subsurface structures probably act as conduits for conveying contaminated plumes into the surrounding ground water.

The results from the physico-chemical parameters of Zango area complemented the VLF EM data. The ion concentrations of the measured parameter differ significantly from WHO permissible limit. This implies that, the water is not suitable for human consumption. The level of Bio-Chemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) were high indicating enormous load of organic compound released by hydro spherical environment. The source of heavy metals (livestock dung) in the study area could be attributed to release of organic materials (carbon) to the soil, and reach the ground water. From the result of the present work, it is recommended that:

i. For the reconnaissance survey, other geo-physical techniques, like, resistivity method, seismic method should be applied to study area, for the effective result of the contamination.
ii. The ground water in Zango should be treated before use.

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