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Geochemical assessments of some hand-dug wells in Oru and it's environs, South western Nigeria.

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ABSTRACT

Water a vital natural resource is increasingly being threatened by rapid population growth and indiscriminate dumping of refuse. Geochemical evaluations of hand-dug wells within Oru were determined to infer the effect on public health. Water samples were collected in hand-dug wells with two samples taken per point, one was acidified with nitric acid (HNO_3) for cation analysis and the other was un-acidified for anion analysis. Geochemical analysis of the water was carried out using inductive couple plasma optical emission spectrometry method in Activation Laboratory Canada, while the Physico-chemical analyses were done at the Petroc Laboratories Ibadan.

The mean values of pH (5.7), total dissolved solids (395). and electrical conductivity (608.8) were found within the W.H.O (2007), and EPA 2005 standard. Na~ was the highest among the cations with concentration ranging from 6.0-48.4mg/l and the dominant anion was HCO_3 with concentration ranging from 35-170mg/l. The chemical characterisation of the water in the study area can be classified as Na-Ca-HCO_3 water, with the class being Alkaline and Earth Alkaline water group.

Trace elements showed the following trend Zn > Ni > Cu. All the trace elements were within WHO and EPA standards. The contamination assessment of water based on Geo-accumulation index and Contamination factor revealed **that** the water **in the study area** were **moderately contaminated with Ni, while the other metals** showed no **contamination.**

KEYWORDS; Quality, Contamination, Trace elements. Geo-accumulation

Introduction

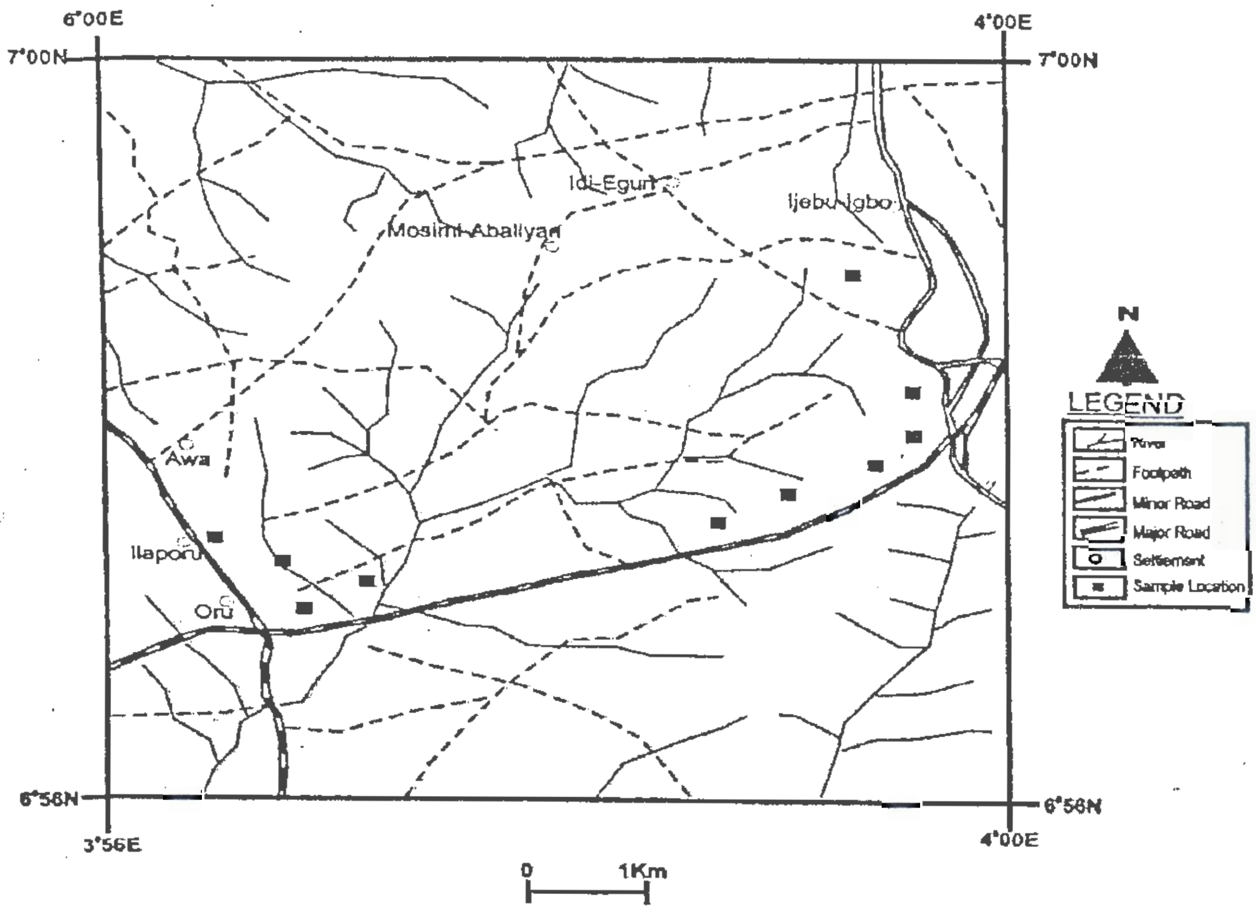
Groundwater, an important water resource in the existence and sustenance of man in both urban and rural areas of Nigeria countries to a great extent depends on its quality Ptummer et al., 2003 Adekunle 2007. The occurrence of groundwater in any area is a consequence of her geology and climate Barker 1992, which has assumed such a high proportion in the alteration of natural environment which has continued to pose a great threat to public health. Groundwater pollution occurs when hazardous substances come into contact and dissolve in the; water that has soaked into the soil. These resources are under threat from pollution either from human life style manifested by the low level of hygiene practiced in the developing nations or from natural resource that could also affect the natural influence of the environment. Environmental health involves j all the factors circumstances and conditions in the environment or surroundings of humans that can influence health and well being, Olayinka (1992), Oshibogun (1998), and Adebanjo (1997) study the geochemistry of surface and ground water in and around Ago-Iwoye and they concluded that most hand-dug wells in Ago Iwoye were good: for human consumption according to the physical: and chemical analysis; which corresponds to the World Health Organization (W.H.O 1998) standard, and also concluded that low alkalinity in the hand-dug wells reveals a typical natural well water that indicates absence of industrial waste. The work is therefore, aimed at ascertaining the effect of incessant increase in population on the already natural water of the hand-dug wells found in the study area.

LOCATION OFTHE STUDYAREA

The area lies within longitude 3° 56' E and 4° 00' E and latitudes 6° 56' N and 7° 00' N 'Fig. 1). The study area is characterized with low hills forming ridges in some places as its topography and enjoys natural vegetation.

GEOLOGICALAND GEOMORPHOLOGICALSETTING

The study area lies within the basement complex of southwestern Nigeria, and underlain by metamorphic rock. The major rock types encountered are undifferentiated biotite hornblende gneiss with intercalated amphibole, pegmatite and granite gneiss. Others includes porphyritic granite and quartzite.



Materials and Method

Fig. 1: Map of the study area showing sample location

Ten (10) water samples were collected around the study area systematically. The pH and Total Dissolved Solid (TDS) were measured in-situ, using a microprocessor based pH tester and a scan model 4076 TDS meter respectively. To avoid contaminations through the use of reactive or metallic container, a clean rubber container was used in drawing water samples from the wells and samples were stored in clean sterilized plastic water bottles. Seven water samples were acidified with dilute Nitric acid (HNO_3) for cation and heavy metal determination, this was to prevent ions from adhering to the surface of the container and to allow the ions to remain in solution, while the remaining three 10ml bottles of water were not acidified and it-was used for anion determinations. Geochemical analysis of the water was carried out in Activation Laboratory Canada, using the Inductive Couple Plasma Optical Emission Spectrometry (ICP-OES) method, while the Physico-chemical analyses were done at the Petroc laboratories Ibadan.

RESULT AND INTERPRETATION

Mean statistical summary (Table 1) of anion reveals the elements to be HCO,> Cl> SO/ while that of cation reveals Na> Ca²> Mg²> 1C. The mean value of pH, EC (us/cm) and TDS (mg/L) (5.7,395, and 608.8) were found to be within the W.H.O (2006) and EPA (2005) standards respectively. The mean value for the elements revealed that all the elements fall below the Highest Desirable level (HDL) and Maximum Permissible level (MPL) of the World Health Organization (WHO, 2006) and Environmental Protection Agency limits respectively (EPA, 2005). Piper Tri-linear diagram (Furak and Languth, (1967)) (Fig 2), showed that 44.4% of the water samples fall into Earth Alkaline Water group (D-E), while 55.6% falls into the Alkaline Water group (F-G), this was also confirmed by the Schoeller diagram (Fig 3). HCO," was found as the dominant anion in the study area, this may be due ; to increase in industries in the study area which leads to industrial effluents getting leached into the soil and ; then infusing the groundwater of the study area. Sodium Absorption Ratio (SAR) (Wilcox (1955)), signifies an excellent to good water these shows the water good for irrigation on plant and soils. A significant positive correlation (Table 2) was observed beiweenNa'-Ca²⁺(0.52),Na⁺-Mg²" (0.87), SO/' - Mg²' (0.76), Cl - Ca²* (0.54), HCO, - Ca * (0.80), TDS - Mg²" (0.77), and Cl - SO/' (0.68). These shows an evidence of a common anthropogenic source found close to latrine and refuse dumps that could have percolated the soil into the groundwater. While the few that are of negative correlation K' - Mg²' (-0.054), K' - Na' (-0.055), SO; -K' (-0.137), CMC (-0.137), HCO, -K' (-0.043) are weak which reveals that the metals can still be from the same anthropogenic source, and they may also be from weathered rocks since they basically show that they are from the same source. HCO, is having a strong and significant correlation with most of the element except K which also correlated negatively with all the elements except TDS, this therefore shows K* to be associated to weathering of the bedrock which now gets into the waters through leaching.

Trace metals

Statistical analysis (Table 3) of trace metals gives the

Table 1: Statistical summary of the major chemical parameters from the study area

Parameter (mg/L)	RANGE	MEAN	STARNDARD DEVIATION	W.H.O (2006) HDL	W.H.O (2006) MPL	EPA (2005)
Ca^{2+}(mg/L)	7.6 -36.4	16.15556	13.50704	75	200	75
Mg^{+}(mg/L)	3.0 - 18.6	7.466667	4.511467	50	150	50
Na^{+}(mg/L)	14.2 - 184.0	41	50.94592	20	200	200
K^{+}(mg/L)	2.0 - 17.0	6.444444	4.740162	10	15	-
SO_4^{2-}(mg/L)	3.4 - 62.4	28.66667	25.2419	200	500	250
Cl^{-}(mg/L)	22 - 156.0	48.06667	40.62774	200	50	200
HCO_3^{-} (mg/L)	31 - 524	138.8889	141.3769	-	-	-
pH	3.7- 6.8	5.744444	0.941761	6.5	9.2	6.5 – 8.5
TDS (mg/L)	80 - 1,023	395	328.3088	500	1500	-
EC (us/cm)	123.9 – 1573.9	608.86	505.3365	400	1480	-
SAR	3.96 -35.09	11.6	0.933	-	-	-

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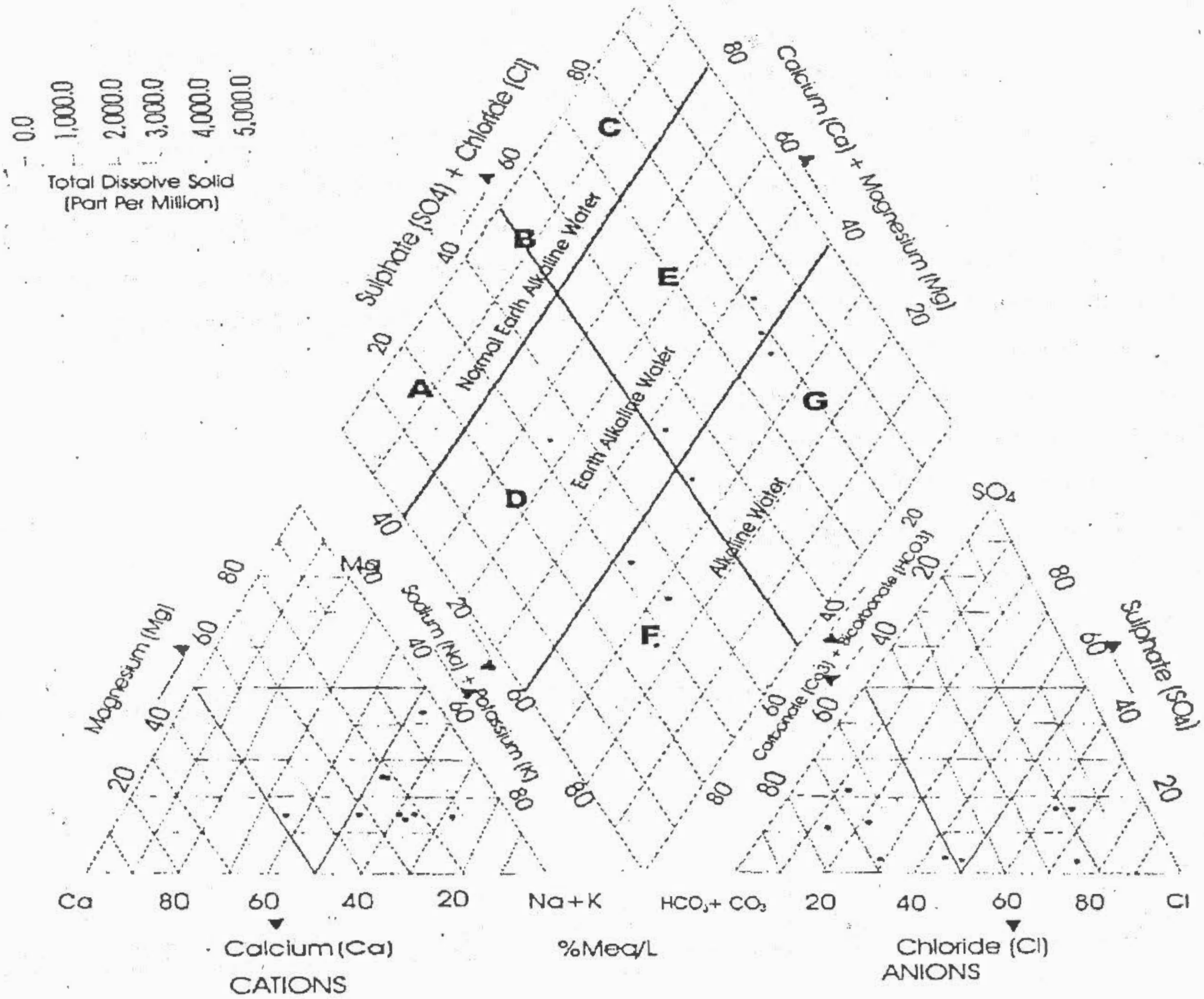

Fig.2: Trilinear diagram of water chemistry data based on Percentages of milliequivalent per liter (After piper 1944)

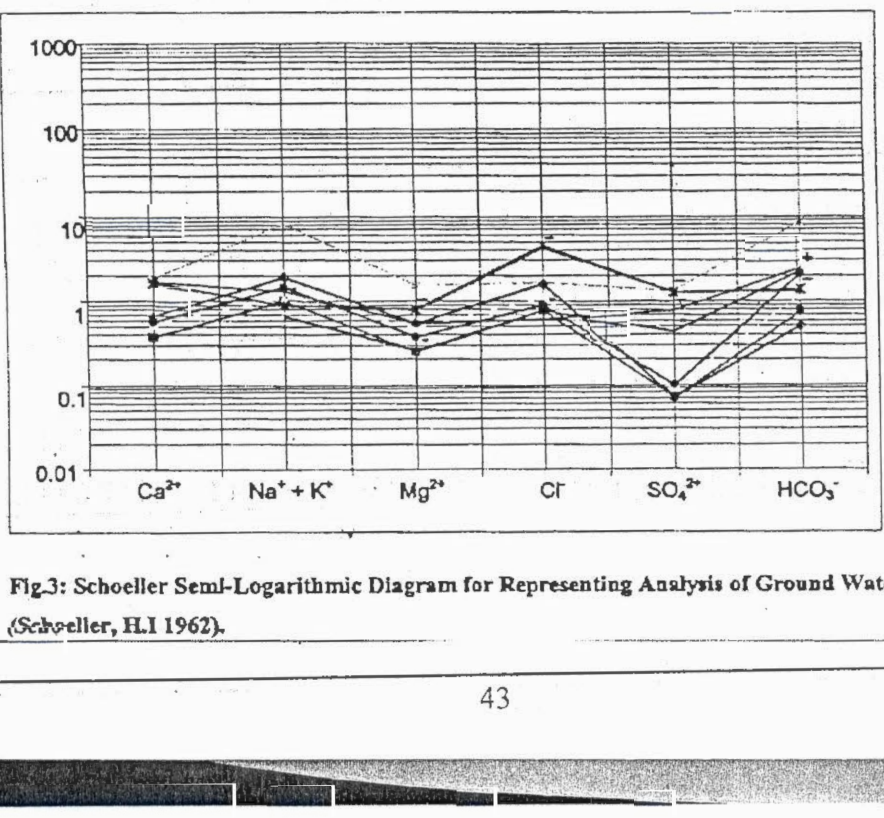

Fig.3: Schoeller Semi-Logarithmic Diagram for Representing Analysis of Ground Water Quality (Schoeller, H.I 1962).

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range as Zn > Ni > Cu. The observed values of elements with their respective pH and TDS were well within the safe limits for W.H.O (2006) and EPA (2005) standards (Fig 4). A strong and positive correlation (Table 4) was observed for all the elements which show that they are from the same source. Geo-accumulation indices (Table 5) of the samples revealed Nickel (Ni), Copper (Cu) and Zinc (Zn) ranges between zero and class one, these implies that the samples are uncontaminated to moderately contaminated (Fig 5). Contamination factor (Table 6) of the elements shows the impact of each metal on the water quality, based on these the samples are moderately contaminated with Ni, while Cu and Zn have a low contamination factor in the samples; Nickel (Ni) has a major contribution (35.7%) due to the closeness of a particular well (L3) to a septic tank. The absence of major industries in the study area could have reduced the metals below the recommended limits.

TABLE 2: CORRELATION OF MAJOR ELEMENTS IN THE ANALYZED WATER SAMPLES

	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	SO_4^{2+}	Cl^{-}	HCO_3^{-}	pH	TDS
Ca^{2+}	1								
Mg^{2+}	**0.641863**	1							
Na^{+}	**0.519819**	**0.869703**	1						
K^{+}	0.448914	-0.05438	-0.05512	1					
SO_4^{2-}	0.492932	**0.755565**	0.419045	- 0.13666	1				
Cl^{-}	**0.540796**	0.336587	0.077012	- 0.13678	0.395487	1			
HCO_3^{-}	**0.556093**	**0.821476**	**0.939053**	-0.0432	**0.510327**	0.024959	1		
pH	0.116591	0.244344	0.151154	- 0.17865	0.414465	-0.14725	0.403195	1	
TDS	**0.798938**	**0.773451**	**0.540485**	0.09553	**0.682506**	0.810661	0.490569	- 0.00668	1

TABLE3: STATISTICAL TABLE OF TRACE ELEMENT

ELEMENTS	MEAN (μg/L)	MEDIAN (μg/l)	RANGE (μg/l)	STANDARD DEVIATION	WHO (2006)	EPA (2005)
Cu	7.57	6	2 – 24	7.7	2000	1300
Ni	30.71	26	12 – 56	18.3	20	-
Zn	89	89	34 - 137	43.9	3000	5000
Ph	5.99	6.0	5.3- 6.7	0.49	6.6- 8.5	6.5- 8.5
TDS	352	341	109- 647	216	1000	1000

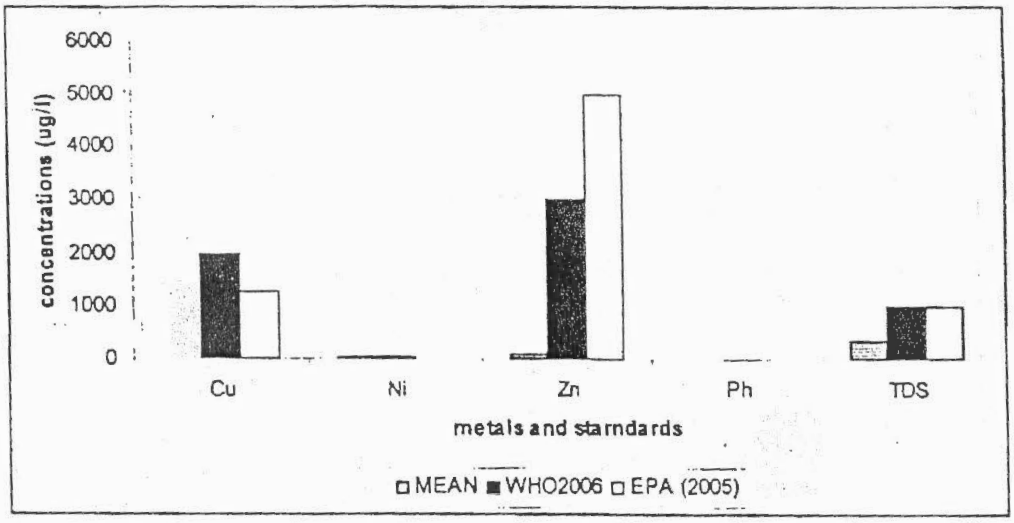

Fig 4: Bar Charts showing comparison of metals with WHO and EPA standards

Table 4: Correlation matrix of Heavy metals

	Cu	*Ni*	*Zn*
Cu	1.000		
Ni	**0.520**	1.000	
Zn	0.321	0.345	1.000

Table 5: Geo – accumulation index of the Samples

Element	1	2	3	4	5	6	7
Cu	-6.97	-9.55	-8.74	-8.58	-9.58	0	-8.96
Ni	0.55	-0.21	0.90	0.67	-1.32	-1	-1.3
Zn	-5.05	-5.04	-5.66	-5.89	-7.05	-5.24	-7.05

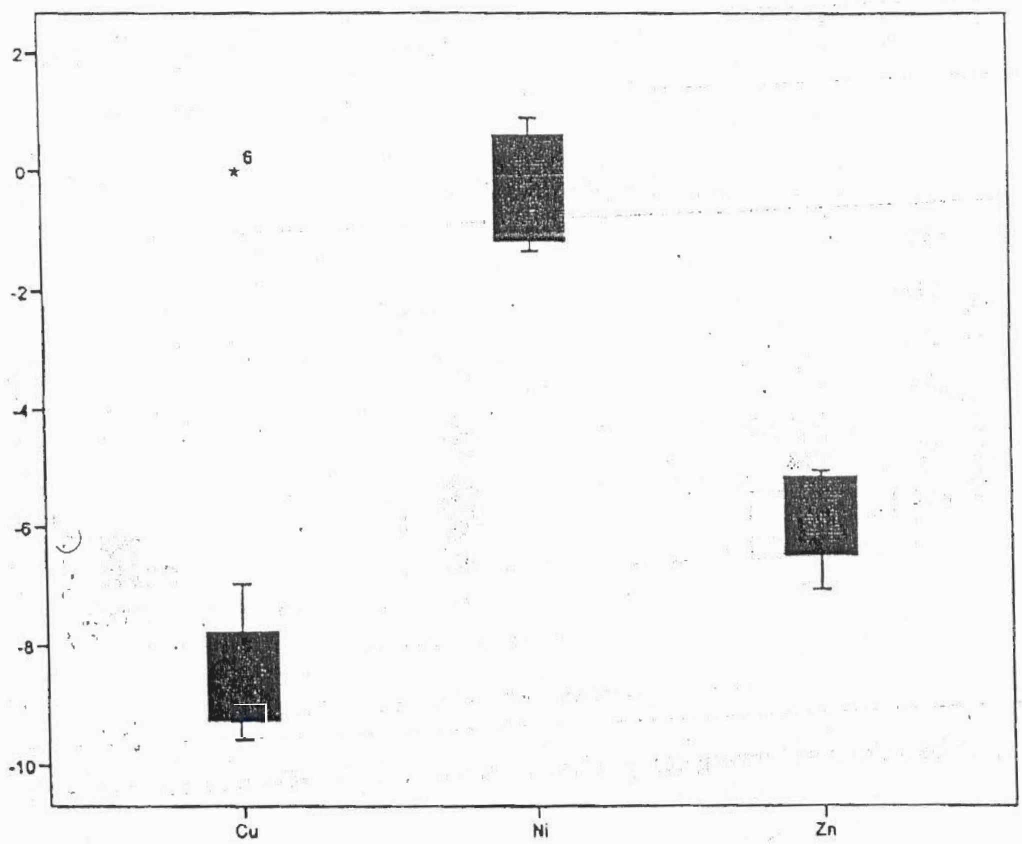

Fig 5: Box plot showing geo-accumulation index of the metals

Table 6: Impact of each Metal on Water Quality

ELEMENT	Contamination Factor	Percentage (%)
Cu	0.004	0.09
Ni	1.54	35.70
Zn	0.03	0.70

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Conclusion on the results of heavy and trace metals reveals that all the total dissolved solids and Electrical conductivity values indicated that the water is fresh; and also good for agriculture and irrigation purpose. It also showed that all the elements are within the WHO (2006) and EPA standard. High bicarbonate seen depicts more industrial influence on the environment which has polluted the typical natural well water. Inter-elemental analysis of these main elements found in the water also showed that they are all from the same anthropogenic source. Enough caution should be made while digging a well not to be placed beside a septic tank. nor sewage dump, and to use a proper non - corrosive cover to prevent runoff and infiltration into them.

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