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Geochemical Analysis of Domestic Groundwater Sources in a Suburb of Ota, Southwestern Nigeria

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Abstract

Groundwater as one of the most valuable natural resources supports human health, economic development and ecological diversity. The activities of many constituents related to groundwater such as micro-organisms, gases, inorganic and organic materials can lead to contamination of well water, municipal drinking water sources and the environment. Therefore, geochemical analyses of domestic groundwater sources within Iju, Southwestern Nigeria have been conducted to determine the groundwater properties of water samples from available hand-dug wells and boreholes within the area. Fifteen (15) water samples sourced from wells and boreholes within the study area were analyzed for their major trace elements using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) in the laboratory and physiochemical characteristics such as pH, total dissolved solids and conductivity were calculated to determine the suitability of such water for agricultural and domestic consumption. The bulk analysis on the water samples revealed that majority of the trace elements when compared with the World Health Organization (WHO) drinking water standards and Acme Laboratory Canada Method Detection Limits (MDL) have values that agree with the recommended limit. These findings show that the present status of groundwater in Iju is good for domestic and agricultural purposes. However, the presence of trace elements such as Lead, Bromide, Copper, Potassium, Manganese, Rubidium and Silicon in fairly high quantities in the groundwater samples which may be as a result of treatment in the water or dissolved salts in the groundwater may constitute major health hazards if not quickly checked. In spite of groundwater studies done in Ota, important information on groundwater resources in Iju is still largely unavailable. Thus, groundwater management can be effectively planned based on these results for the study area.

Keywords: Boreholes, Geochemical Analysis, Groundwater Management, Hand-Dug Wells, Trace Elements

1. Introduction

One major factor that affects the quality of groundwater is pollution. Pollution is simply the introduction of foreign materials that are capable of altering the quality and conditions of the original material. Pollution of water is a major challenge confronting the world today[1]. Water pollution can be of different sources which may be natural or artificial. Contamination of water as a result of artificial sources may be due mainly to the activities of man such as industrialization, agricultural activities and poor waste management practices. Sources identified as natural causes of contamination may be climatic changes, saline water intrusion, leaching of geological materials into water sources. The chemical interactions between groundwater and the geological materials of soils and rock samples could contribute to water contamination[2]. This is because the rock is an embodiment of different chemical materials which can alter the quality of groundwater if the quantity is in excess of the stipulated standards. Rock or soil materials are known to be of chemical origin and as a result can easily leach into the water sources and affect their quality.

During the last decade, it is observed that groundwater pollution has drastically increased due to human activities. Consequently, number of water borne diseases

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has also increased among publics[3]. In a related development, poor water quality has been identified as one of the major causes of disease outbreak especially in some under-developed countries. Therefore, urgent steps must be taken in order to ensure the quality of water that is consumed by people. The importance of water as one of the vital means of livelihood cannot be down played. The measure of the portability of water is a function of its purity. Groundwater has been identified as one of the major sources of fresh water. It accounts for about 30% of the earth's fresh water[4]. In[5] reported that the pressure of high population, climate change and the rapid pace of development of human activity constitute to the poor quality of water in many parts of the developing world. In[1] observed that one of the prominent challenges affecting groundwater quality is the emerging pollutants that are present in the environment. In[6] evaluated the connection between inland and coastal groundwater systems. He engaged the use of geochemical indicators. In[7] proved the possibility of studying and understanding the hydrochemical evolution of groundwater.

The inhabitants of Iju, the study area depend on groundwater largely for their drinking and domestic purposes therefore, efforts must be made to compare the chemical composition of the water sources consumed by people with the recommended standards in order to ascertain its safety. In[8] used Vertical electrical soundings to investigate aquifer properties in Atan-Ota, but there is no significant work on water quality assessment in Iju-Ota. In view of the above, this present study makes effort to conduct the geochemical analysis of the domestic water sources in Iju, a suburb area of Ota, Southwestern Nigeria.

2. The Study Area

The study area, Iju, is located along Idiroko road in Ado – Odo/Ota Local Government Area of Ogun State (Figure 1). It is a gently sloping area which falls within the eastern Dahomey Basin of southwestern Nigeria. It lies approximately between latitude 6˚ 40N and 6˚ 41N and longitude 3˚ 07 E and 3˚ 08 E. The mean annual rainfall that forms the major source of groundwater recharge in the area is greater than 1800 mm. The area consists of sediment of clay, unconsolidated sands and mud with a varying proportion of vegetable matter along the coastal areas while the alluvial deposit consists of coarse claying unsorted sand with clay lenses. Basically, sedimentary terrains have good aquifers.

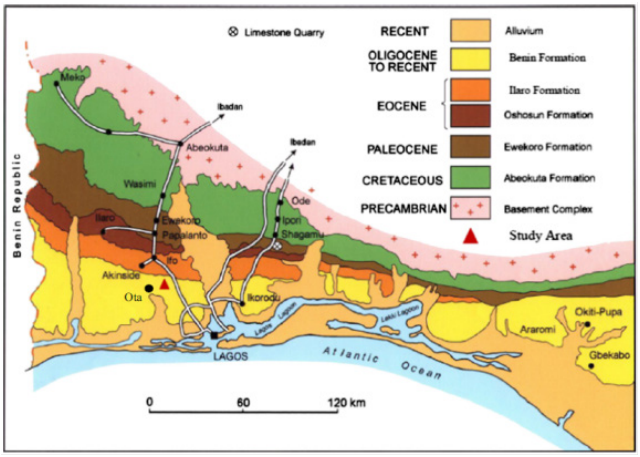


Figure 1. Geological map of the Dahomey (Benin) basin showing the study area[9].



Key: -- Wells and boreholes

Figure 2. Location of wells and boreholes in the study area (Google map).

3. Materials and Method

In this present study fifteen (15) water samples were collected in a previously cleaned 50ml plastic bottle from four (4) wells and eleven (11) boreholes around the study area (Figure 2.) in April 2015. A GPS was used for determining the geographical coordinates of these sample locations as shown on the google map in Figure 2. Standard methods were used for the determination of the chemical and physical characteristics of the water[10]. The characteristics include Nitrate, Sulphates, HCO^3, Phosphate, Chloride, pH, conductivity, turbidity, Total Hardness (TH), salinity, alkalinity, temperature, Dissolved Oxygen (DO),

Table 1. Results of the physio-chemical characteristics of groundwater in Iju and environs

Parameters	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	M.V	WHO (2011)
pH	6.72	6.97	6.73	6.99	7.33	6.69	6.28	6.05	5.92	7.51	7.40	7.0	6.89	6.47	6.22	6.74	6.5 – 8.5
DO (ppm)	5.0	5.3	5.1	5.4	5.5	5.4	5.1	5.2	5.3	5.1	5.4	5.5	5.0	5.5	5.3	5.24	5.0
Turbidity(NTU)	0.0	0.0	0.0	0.10	0.0	0.20	0.10	0.0	0.20	0.30	0.10	0.40	0.10	0.30	0.20	0.2	1-5
Conduc ($uScm_{-1}$)	96.4	65.3	36.6	65.3	32.4	49.0	38.7	37.0	38.9	199.0	73.60	64.10	43.2	32.7	33.60	60.38	500
Salinity (%)	0.04	0.04	0.02	0.03	0.02	0.03	0.03	0.02	0.03	0.06	0.04	0.03	0.05	0.01	0.02	0.04	1.40
TDS (ppm)	44.5	29.4	16.6	16.6	14.6	22.4	18.3	16.90	17.80	93.60	33.60	29.20	37.20	15.0	20.0	28.38	500
Alkalinity (ppm)	6.0	6.0	6.0	7.0	8.50	6.0	4.50	4.50	4.0	10.0	9.0	8.0	7.0	5.0	4.5	6.4	-
Temperature	26.1	26.3	26.5	26.7	26.6	26.0	26.4	26.7	26.8	27.1	27.0	27.2	27.0	27.1	27.0	26.7	40
T H (ppm)	ND	ND	ND	8.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.0	250
Colour	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	-
NO_3 (ppm)	2.92	2.88	3.10	3.10	2.66	2.70	2.30	2.50	2.70	3.10	3.40	3.70	4.13	2.60	2.44	2.74	8.5
SO_4 (ppm)	2.0	1.77	1.90	1.90	1.50	1.52	1.66	1.72	1.60	1.30	1.44	1.68	1.77	1.81	1.66	1.68	250
HCO_3 (ppm)	ND	ND	ND	ND	0.51	ND	ND	ND	ND	0.54	0.52	0.40	ND	ND	ND	0.49	0.03
PO_4 (ppm)	0.02	0.01	0.01	0.01	0.02	0.03	0.11	0.01	0.02	0.03	0.02	0.03	0.01	0.02	0.01	0.23	0.06
Cl (ppm)	20.0	18.0	0.0	0.0	8.0	16.0	13.0	8.0	12.40	32.20	20.0	16.0	22.0	8.0	12.0	12.37	250
TSS(ppm)	0.40	0.30	0.10	0.10	0.40	0.30	0.21	17.1	18.0	93.9	33.7	29.3	37.3	15.1	20.1	17.75	-

KEY: ND – No Detection, C- Colourless, M.V – Mean value,

and Total Solid Suspended (TSS). Other trace elements were analyzed using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) in Acme Laboratory Canada. The chemical quality data are shown in Table 1. Other data are presented in Tables 2(a) and 2(b).

4. Results and Discussion

4.1 Hydrogeochemistry

The mean value of all parameters measured was calculated and the values were compared with the[12] World Health Organization (WHO) water standard guidelines. Basically turbidity, colour, taste and temperature make up the list of physical water quality parameters and because groundwater is colourless, odourless and without specific tastes the concern is then the chemical qualities[11]. In the study area, temperature of groundwater ranged between 26.1˚C and 27.2˚, this is normal because the cooler the better, as excessive high water temperature enhances the growth of microorganisms. Related problems such as corrosion, taste, colour, and odour may also occur[12].

4.1.1 pH

The pH is a measure of the number of hydrogen ions or protons present and it is measured with a pH meter[13]. In pH measurement, values less than 7 are acidic and greater than 7 is alkaline (basic) and exact 7 is neutral. Therefore, for the present study areapH of the analyzed samples ranged between 5.92 and 7.51 with a mean value of 6.74 which are within the permissible limits of World Health Organization (WHO)[12] standard in drinking water (Table 1).

4.1.2 Sulphate

(SO_4^{2-}): Concentration of sulphate ranged from 1.30 to 2.0 mg/l, this range falls within the recommended limits for drinking water by WHO[12]. Nitrate concentration ranged between 2.3 and 4.3 which are within 50 mg/l, the acceptable limits of WHO. The mean value 12.37mg/l of chlorine detected in the groundwater is normal as chlorine has no specific health hazard in water at this value, although W10 seems to have higher chlorine content.

4.1.3 Salinity

The salinity of the analyzed samples in the study area range between 0.01% and 0.06%, this is normal although there is no specific recommendation from WHO but salts can be highly harmful as they can stunt the growth of plants, inhibiting the uptake of water into the plant. For irrigation purposes, salinity and toxicity are necessary evaluations to be considered[14]. The turbidity range is between 0.10 and 0.40 NTU, this is far less than the 1 - 5 NTU recommended by WHO[12].

4.1.4 Total Dissolved Solids (TDS)

TDS is the combination of inorganic salts and some small amounts of organic matter that are dissolved in a given volume of water. For water to be portable, a Total Dissolved Solids (TDS) level of less than or about 500mg/l is generally acceptable (USEPA). The major components of total dissolved solids include bicarbonate (HCO_3^-), sulphate (SO_4^{2-}), hydrogen (H^+), silica (SiO_4), chlorine (Cl^-), calcium (Ca^{+2}), magnesium (Mg^{+2}), sodium (Na^+), potassium (K^+), nitrates (NO_3^-), and phosphate (PO_4^{3-})[15]. So, the TDS in the water samples ranged between 14.6mg/l and 93.60mg/l is totally acceptable for drinking water.

4.1.5 Dissolved Oxygen (DO)

The amount of oxygen present or dissolved in water is termed dissolved oxygen. DO is basically essential for the survival of aquatic organisms but also affects other water indicators such as the odor, taste and clarity. So, it is a good indicator of water quality. Concentration of DO in the samples ranged between 5.0 and 5.5mg/l, this is slightly higher than the WHO recommended limit of 5.0 mg/l. No health-based guideline though, but very high level of oxygen may worsen the corrosion of metal pipes[12].

4.1.6 Total Hardness Content (THC)

The higher the calcium and magnesium content the greater the degree of hardness in groundwater. THC was not detected in almost all the water samples except for W4, this may be caused by a variety of dissolved calcium and magnesium cations present in the well as at the time of study.

4.1.7 Electrical Conductivity (EC)

Electrical conductivity depends on the degree of temperature, ionic concentration and types of ion present in the water[13]. Thus, electrical conductivity gives a qualitative picture of the quality of groundwater[16]. The conductivity values detected from the groundwater in the study area range between 32.4 and 199 μ S/cm, this is within the 500 μ S/cm acceptable limits of WHO recommendations. The excessively high conductivity observed in W10 (Table 1.) may be as a result of its high chlorine content.

4.2 Trace Elements

The results of twenty (20) elements for sample 1 through sample 15 carried out in ACME laboratory Canada are shown in Table 2.

Aluminium (Al): The value ranged between 1 and 21 ppb. According to USEPA the acceptable range is 50 to 200 ppb i.e., (0.05 to 0.2mg/l). All the samples are far below the acceptable range, making them suitable for drinking and other domestic purposes.

Arsenic (As): The maximum permissible of Arsenic value according to WHO is 100 ppb (0.1 mg/l), beyond this limit, water becomes toxic and causes skin damage, circulatory problem which increases skin cancer. The values got from the analysis are less than 0.5 ppb, making all fifteen sample fall below WHO limits, thereby making the water Arsenic free.

Boron (B): Values detected is less than 0.5 ppb in all the samples. The values are far below the WHO recommendation limit of 0.3 mg/l (300 ppb). Making the

Table 2. **(a)** Result for the trace elements (Al–Cu) analyzed on the 15 water samples (ACME Laboratory Canada)

MDL – Method Detection Limit (b) Result of trace elements (Dy – Ni) analyzed on the I5 water samples (ACME laboratory Canada)

(a)

	Analyte	Dilution	Al	As	B	Ba	Be	Br	Ca	Cl	Co	Cr	Cu
	Unit		**ppb**	**ppb**	**ppb**	**ppb**	**ppb**	**ppm**	**ppb**	**ppb**	**ppb**	**ppb**	**ppb**
	MDL	**1**	**0.5**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.02**	**0.5**	**0.01**	**0.01**
	WHO(ppm / ppb)		**200**	**100**	**300**	**1000**	-	**0.025**	-	-	-	**50**	**1500**
	NSDWQ (ppb)		**0.002**	**0.00001**	-	**0.0007**	-	-	-	**0.25**	-	**0.00005**	**0.001**
Sample 1	Water	1	10	<0.5	<5	30.2	0.08	30	12.3	7	0.33	0.9	47.4
Sample 2	Water	1	6	<0.5	<5	27.23	0.21	27	8.65	5	0.38	1.5	20.2
Sample 3	Water	1	5	<0.5	<5	20.53	0.08	25	1.71	4	0.48	0.7	24.2
Sample 4	Water	1	3	<0.5	<5	12.38	0.07	22	6.36	5	0.22	1	7.7
Sample 5	Water	1	5	<0.5	<5	16.24	<0.05	24	1.88	4	0.21	1	10.4
Sample 6	Water	1	4	<0.5	<5	21.36	0.06	27	1.55	5	0.61	0.5	6.9
Sample 7	Water	1	9	<0.5	<5	22.5	0.16	28	1.78	5	0.46	0.4	54.6
Sample 8	Water	1	6	<0.5	<5	17.79	0.11	26	1.29	4	0.36	1.5	15.2
Sample 9	Water	1	8	<0.5	<5	22.69	0.07	24	1.4	4	0.44	0.6	15.3
Sample 10	Water	1	10	<0.5	<5	20.37	<0.05	18	42.3	4	0.72	2.6	1.9
Sample 11	Water	1	21	<0.5	<5	22.69	0.08	23	9.55	5	0.31	0.8	12.6
Sample 12	Water	1	1	<0.5	<5	20.21	0.06	25	7.82	5	0.29	0.7	5.3
Sample 13	Water	1	4	<0.5	<5	20.43	0.06	19	11.1	4	0.31	1.1	10.7
Sample 14	Water	1	3	<0.5	<5	18.54	0.09	22	2.83	4	0.44	0.7	13.8
Sample 15	Water	1	14	<0.5	<5	19.74	0.1	23	0.92	4	0.39	0.6	11.7
Range			1-21	-	-	12.38 -30.2	0.06-0.11	18 - 30	0.92 – 42.3	4-7	0.22-0.72	0.4 - 2.6	1.9 – 54.6
Mean			7.2	-	-	20.86	0.097	24.2	7.43	4.6	0.40	0.97	17.2
STD			5.09	-	-	4.21	0.04	3.23	10.4	0.83	0.14	0.55	14.8

(b)

	Analyte	Dilution	Dy	Fe	K	Li	Mg	Mn	Rb	Na	Si
	Unit		**ppb**	**ppb**	**ppb**	**ppm**	**ppb**	**ppb**	**ppb**	**ppb**	**ppb**
	MDL	**1**	**0.01**	**0.05**	**0.01**	**0.01**	**0.05**	**0.05**	**0.01**	**0.06**	**0.02**
	WHO(ppm/ ppb)		-	**1000**	-	-	-	**500**			**100**
Sample 1	Water	1	0.08	<10	0.93	1.8	1.28	10.5	2.74	6.69	5816
Sample 2	Water	1	0.03	<10	0.37	1.6	0.77	8.97	1.16	3.46	5554
Sample 3	Water	1	<0.01	<10	0.16	0.7	0.45	7.39	0.49	4.32	5207
Sample 4	Water	1	<0.01	<10	0.15	0.9	1.9	6.43	0.6	4.62	5244
Sample 5	Water	1	0.01	<10	0.19	0.7	0.39	0.57	0.41	4.33	4972
Sample 6	Water	1	<0.01	<10	0.17	0.7	0.45	9.77	0.6	5.37	5344
Sample 7	Water	1	0.02	<10	0.13	0.7	0.45	7.49	0.41	5.11	5189
Sample 8	Water	1	<0.01	<10	0.11	0.7	0.41	7.56	0.31	4.71	5150
Sample 9	Water	1	<0.01	<10	0.27	0.7	0.5	9.44	0.45	4.67	5223
Sample 10	Water	1	<0.01	<10	2.17	1.5	0.72	52.5	9.94	3.45	8403
Sample 11	Water	1	<0.01	<10	0.58	1.2	0.72	8.16	1.46	4.29	5749
Sample 12	Water	1	<0.01	<10	0.13	0.6	0.44	5.84	0.4	4.69	5082
Sample 13	Water	1	<0.01	<10	0.25	1	0.68	9.12	1.21	3.67	5292
Sample 14	Water	1	<0.01	<10	0.18	1.7	0.55	9.31	0.52	4.52	5340
Sample 15	Water	1	<0.01	<10	0.12	0.7	0.41	8.31	0.3	5.23	5214
Range			0.01-0.08	-	0.11-0.93	0.6-1.8	0.39-1.9	0.57-52.5	0.3 - 9.94	3.45 – 6.69	4972-8403
Mean			0.035	-	0.39	1.01	0.67	10.8	2.36	4.61	5518.6
Std			0.03	-	0.54	0.43	0.41	11.8	2.44	0.82	830.73

samples boric free. The male reproductive tract is a consistent target of boric acid toxicity[12].

Barium (Ba): Barium in water is from natural sources. Values ranged between 12.38 and 30.2 ppb. All samples fell below the USEPA[17] recommended limit of 2 mg/L i.e., 2000 ppb, beyond this limit causes increase in blood pressure.

Bromide (Br): The concentration of bromine in the samples ranged between 18 and 30 ppb. Five samples, that is, samples 1, 2, 6, 7 and 8 exceeded the WHO recommended limit of 25 ppb. The risk of lifetime cancer is evident on long term exposure. No recommended value from USEPA.

Beryllium (Be): The beryllium concentration in samples 5 and 10 has values less than the 0.05 ppb Method Detection Limits recommended (MDL) by ACME. Other samples exceeded this limit thereby making the water prone to related health hazard, such as intestinal lesions which is known to occur beyond the recommended value.

Calcium (Ca): The values ranged between 0.92 and 42.28 ppb. All values exceeded the Acme detection limit of 0.05 ppm. Calcium is an essential body mineral. Drinking water is the best medium of getting the correct absorption of it. Lack of calcium develops osteoporosis. In excess as in all the samples, calcium deposits on the joints causing them to creep.

Chlorine (Cl): The values ranged between 4 and 7 ppb. Chlorine is present in most disinfected drinking water at concentration of 0.2 to 1 mg/l. All values fell below the WHO guideline value of 5000 ppb (5 mg/l) and the USEPA[17] recommended limits of 4000 ppb (4.0 mg/L). No specific adverse effects have been observed.

Cobolt (Co): The values ranged from 0.21 to 0.72 ppb in all the fifteen samples. All values were within the ACME detection limit of 0.5 ppb except sample 6 and 10 with exceeded values of 0.61 ppb and 0.72 ppb respectively. Cobolt is beneficial for humans because it's a part of Vitamin B12 which is essential for human health. Effects

at high concentration as with samples 6 and 10 is asthma, pneumonia, vomiting and nausea, vision problems and heart problems.

Chromium (Cr): The analyzed values ranged from 0.5 t0 2.6 ppb. All value exceeded the ACME detection limit of 0.01 ppb, thereby making the water excessive of chromium. The potential health effect of this is allergic dermatitis[17].

Copper (Cu): WHO recommendation is 1.3mg/L. The detection limit of ACME is 0.01 ppb. Copper have astringent taste but essential element for metabolism. The value of Cu in the fifteen water samples ranged from 1.9 to 54.6 ppb, all of which exceeded both WHO and ACME Lab detection limits. Sample 1 (Hand-dug well) and sample 7 (Borehole) values are excessively high, that is, 47.4 ppb and 54.6 ppb respectively. Copper in our diet is necessary for good health. You eat and drink about 1,000 micrograms (1000 μ g) of copper per day. Drinking water normally contributes approximately 150 μ g/day. Effects from drinking water which contains elevated levels of copper include vomiting, stomach cramps and nausea.

Lead (Pb): The results ranged between 0.3 and 19.1 ppb. Thirteen samples have values higher than the ACME detection limit of 0.2 ppb. Lead occurs naturally in the environment. It has a subtle effect on the intellectual development of infant and children. Infants and toddlers are particularly vulnerable; their growing bodies absorb lead more easily and excrete lead less efficiently than adult. Toxic effects are usually due to long term effect exposure as in the affected samples above.

Potassium (K): Values ranged between 0.11 ppb and 0.93 ppb. All value exceeded the Acme recommended limit 0.01 ppb. Potassium occurs in various mineral such as feldspars. It is a dietary requirement for nearly any organism because it plays an important role in nerve functions. It is weakly hazardous in water but toxicity is usually caused by other components in a compound e.g., In high doses, potassium chloride interfere with nerve impulses, which interrupts with virtually all bodily functions and mainly affect heart functioning.

Manganese (Mn): The concentration of manganese in the samples ranged from 0.57 to 52.53 ppb. All sample exceeded the ACME Method Detection Limit (MDL) of 0.1 ppb and fall within the WHO recommendation limits of 0.5mg/l (500 ppb). Excess of manganese in water produces bad taste and would impair the portability of the water.

Rubidium (Rb): Results ranged between 0.3 ppb in sample 15 and 9.94 ppb in sample 10. All value exceeded the ACME detection limit of 0.01 ppb. It is water reactive and moderately toxic by ingestion. Signs and symptoms of excess Rubidium as in all the samples are; skin and eye burns failure to gain weight, ataxia, hyper irritation, skin ulcer and extreme nervousness.

Silicon (Si): Values are extremely high, ranged between 4972 ppb and 8403 ppb in all the fifteen samples. All values exceeded the ACME detection limit of 0.02 ppb. Silicon concentrates in no particular organ of the body but is found mainly in the connective tissues and skin. Excess of it as in the samples may cause chronic respiratory effects.

Consequently, the high silicon content observed in the groundwater samples (Table 2(b)) may be as a result of the abundance of the element in the earth's crust. Silica is present in about sixty percent of all rocks and the erosion of those rocks releases into the soil, streams and groundwater all forms of silica and silicates[18]. Silicon is inert and harmless in water; has no nutritional value but slightly soluble. When pH exceeds 8.0: silicon acid turns into silicate anions and silica's solubility increases. Naturally silicon does not exist in its pure form but rather is always combined with Oxygen, this may account for the high dissolved oxygen values revealed by the physiochemical analysis (Table 1).

Water treatment processes also lead to the presence of some minerals such as manganese, phosphate, calcium, zinc,and sodium compounds[19]. For daily water requirements in human's necessary intake, arthropods and desert animals alike, water generated from biochemical metabolism of nutrients provide a small fraction. A variety of trace elements are present in virtually all portable water, some of which play a significant role in metabolism. For example potassium, sodiumand chloride are commonly found chemicals in small quantities in most waters and these elements play a role in body metabolism[20]. Elements such as fluoride, while beneficial in low concentrations, can cause dental problems and other issues when present at high levels.

5. Conclusion

The physiochemical analysis on the water samples from wells and boreholes within Iju and its environs revealed the groundwater is of good quality and may be useful

for drinking, domestic and agricultural purposes if the dissolved oxygen content could be reduced. The values from the hand dug wells are in no way different from the other groundwater samples from borehole, except for W10 which has a high chlorine content and hence, high conductivity. This may be as a result of treatment the water was subjected to, as at the time of sample collection. Trace elements such as Lead, Copper, Barium and Zinc in fairly high quantities in the groundwater samples may constitute major health hazards if not quickly checked. However, protection and management of groundwater resources in the study area is highly recommended to guarantee the quality of groundwater in the vicinity.

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