



Physico-Chemical Characterization of Ground Water, Case Study of Okene, North Central Nigeria

Authors

¹Onsachi, J.M., ²Yakubu, H.M., ³Shaibu, M.M., ⁴Gyang, D.S.

¹Dept of Minerals and Petroleum resources Engineering, Kogi state Polytechnic, P.M.B 1101 Lokoja

²Dept of Minerals and Petroleum resources Engineering, Kogi state Polytechnic, P.M.B 1101 Lokoja

³Dept of Minerals and Petroleum resources Engineering, Kogi state Polytechnic, P.M.B 1101 Lokoja

⁴Dept of Geology, College of Art, Science and Technology, Kurgwi, Plateau state

Email: *josephonsachi@yahoo.com

Abstract

Okene is fast becoming an urban city and the search for groundwater is ever on the increase. Peoples resulted to drilling of boreholes in order to supplement the earth dam that has served as the only source of water for over forty years in the area. In order to investigate the quality of water in the area, 15 water samples were taken randomly but spread around Okene town. These samples were subjected to various laboratory analyses. The result of the test shows that the pH of water sample from the water board was 4.8 which indicated that the water is acidic as against the 6.5 to 8.5 recommended by the WHO standard for quality drinking water. The other physical parameters like Total dissolved solid, Electrical Conductivity, the average Alkalinity of the water samples is 19.0 mg/l and the Temperatures are within the WHO standard. Chemical elements like SO_4 , NO_3 , Cl, HCO_3 , Na, Mg, K, Ca, Fe, As, etc Fall within the WHO permissible limits.

Geology of the Study Area

Okene lies within the North Central Basement Complex of Nigeria. The Basement Complex rocks of lower Palaeozoic to Precambrian ages underlies about half of the entire landmass of Nigeria. These rocks are represented by migmatite gneiss and intrusive into these basement rocks are the Pan-African granite (Turner, 1971). The study area is characterized by the following rock types: older granites of Pan African age, highly weathered migmatites gniess, melanocratic banded gneiss with faults of various orientations that dips between 45^0 to 85^0 .

Materials and Method of Study

50cl of water bottles were used for the collection of water samples for analysis at the Regional water Laboratory in Akure, Ondo State. The containers were washed with detergent, rinsed with distilled water, dried and sterilized at 150^0 for 2 hours. The sampled bottles were rinsed twice

with the sampled water before sampling and during sampling, the water is agitated. Two water samples were collected from each location; one is acidified with nitric acid while other was not acidified.

The sample bottles were tightened to prevent air from oxidizing the element in the water. The samples were transported to Akure regional water laboratory for analysis where it was kept in the refrigerator awaiting analysis.

The water samples were taken from the surface (stream) groundwater (hand dug well, borehole). Water were collected at random and labeled according to their location as L1, L2, L3, L4, L5, L6, L7, L8, L9, L10..... L15 respectively.

Fifteen numbers (15) of samples were collected in Okene L.G.A.

The following are the various sources of the water.

- Motorized borehole six (6)

- Hand pumping borehole two (2)
- Stream water one (1)
- Dug well water five (5)
- Water board one (1)

The samples were analyzed for physical properties such as total dissolved solid. (TDS), electrical conductivity (EC),PH, temperature e.t.c. while the water was equally analyzed for major and some trace element.

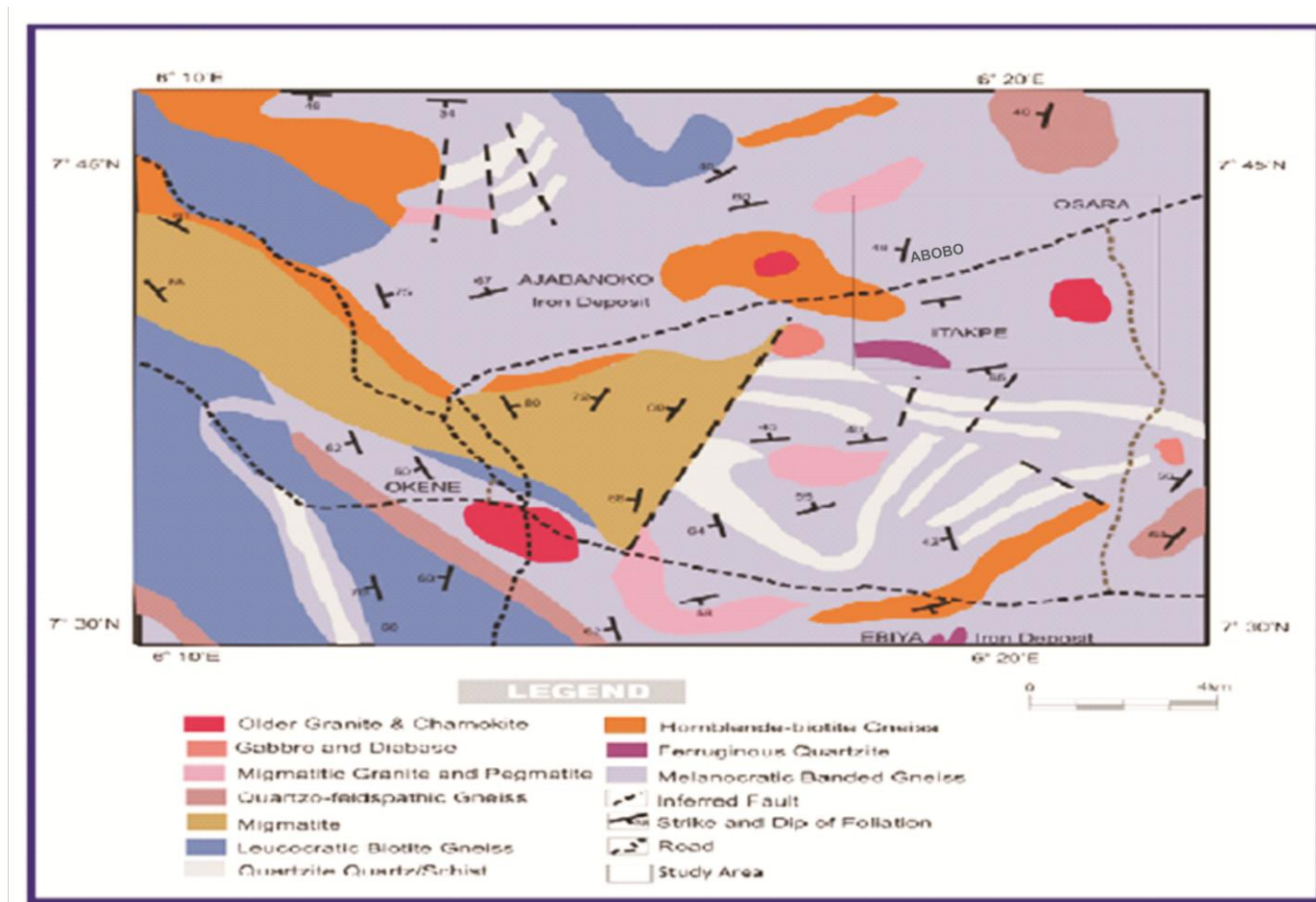


Fig. : Geology of the study Area

Analysis Procedures Analysis

- ❖ Manganese (Mn), chromium (Cr^{2+}), (As), iron (Fe) is measure by using atomic absorption spectrophotometers (AAS).
- ❖ Sodium and potassium (Na and K) are measure by using Sherwood flame emission spectrophotometry.
- ❖ Calcium (Ca) and calcium hardness ($CaCO_3$), alkalinity magnesium (Mn), Magnesium hardness ($CaCO_3$), Chloride Ca^{2+} is by titration.
- ❖ Nitrate and sulphur are measure by using UV spectrometer

Analysis Procedures

- ❖ Manganese (Mn), chromium (Cr^{2+}), (As), iron (Fe) were analyzed using atomic absorption spectrophotometers (AAS).
- ❖ Sodium and potassium (Na and K) were analyzed by using Sherwood flame emission spectrophotometry.
- ❖ Calcium (Ca), calcium hardness, alkalinity, magnesium (Mg), Magnesium hardness, Chloride ions by titration.
- ❖ Nitrate and sulphur are measure by using UV spectrometer

Table 1: Location Of The Study

Location	Name of Place	Latitude (N)	Longitude (E)	Elevation (M)
L1 WB	Okene Water Board	0194106	0836164	345
L2 MBH	Okene NEPA Road	0194213	0835769	380
L3 HPBH	Chief Imam Iruvuchebe	0194424	0835411	395
L4 MBH	Idozumi	0194824	0835399	397
L5 MBH	Bariki Wand	0195174	0835302	406
L6 MBH	Orietesu	0195357	0834510	402
L7HDWW	Idoji Market	0195357	0834510	401
L8 HWW	Eyinare Idoji	0195649	08345166	391
L9 MBH	Isiaku Ido- dokto	0197131	0833249	340
L10 HDWW	Idogivo Idogi along AAMCO	0195707	0834580	396
L11 HDWW	Inike Junction	0195906	0834865	318
L12 HDWW	Inike, near AAMCO	0195952	0835165	376
L13 HDWW	Idogigo I	0195397	083587	399
L14MBH	Idogido II	0195391	0835381	399
L15 SW	Arigo Road	0191089	0834229	649

Table 2: Summary of physio-chemical parameters in water samples

S/N	Physical & chemical Elements	No.	Min	Mix	Range (mg/l)	Sum	Mean (mg/l)	Standard deviation	variance	WHO 2004
1	Temperature	15	26.4	26.9	0.5	399.1	26.6	0.134	0.018	Ambient
2	pH	15	4.80	7.62	2.82	101.37	6.758	0.632	0.399	6.5-8.5
3	Turbidity	15	0.33	6.71	6.38	23.26	1.55	1.815	3.295	
4	Conductivity mg/l	15	104	339	235	3584	238.9	185.56	34432.72	750 mg/l
5	Total Dissolved solid mg/l	15	69.7	474	404.3	2404.8	160.32	124.17	15417.49	500mg/l
6	Total Hardness CaCO ₃ mg/l	15	160	528	368	4815	321	100.97	10194	
7	Calcium Hardness CaCO ₃ mg/l	15	60.0	200	140	2077.8	138.52	41.93	1758.12	
8	Magnesium Hardness CaCO ₃ mg/l	15	44.0	396	352	2739.9	182.67	87.06	7580.09	
9	Nitrate (NO ₃) mg/l	15	4.10	21.7	17.6	212.29	14.153	5.14	26.369	50mg/l
10	Iron (Fe) mg/l	15	0.06	0.21	0.15	1.5975	0.1065	0	0	0.3mg/l
11	Alkalinity mg/l	15	22.0	172	150	199.95	13.33	223.47	49937.85	
12	Manganese (Mn) mg/l	15	0.01	0.03	0.02	0.3	00.2	0	0	0.05mg/l
13	Calcium (Ca ²⁺) mg/l	15	24.1	80.2	56.1	832.8	55.52	16.78	281.63	75mg/l
14	Magnesium (mg ²⁺) mg/l	15	10.7	96.6	85.9	711	47.4	21.19	449.31	50-200mg/l
15	Sulphate (SO ₄ ²⁻) mg/l	15	5.00	128	123	1414	94.27	43.6	1896.6	100-200mg/l
16	Chloride (CL ⁻) mg/l	15	23.9	231	207.1	2240.5	149.37	75.2	5656.3	250mg//
17	Sodium (Na) mg/l	15	15.5	186	170.5	1455.15	97.01	48.33	2336.12	50-200mg//
18	Bicarbonate (HCO ₃) mg/l	15	22.0	172	150	1700	113.33	42.61	1815.97	200mg/l
19	Potassium (K ⁺) mg/l	15	3.00	56.0	53	408	27.2	17.93	321.23	100mg/l
20	Arsenic mg/l	15	0.00	0.00	0	0	0.00	0	0	0.01mg/l
21	Chromium(Cr ⁶⁺) mg/l	15	0.03	0.06	0.03	0.0615	0.041	0	0	0.05

Results

The results of the concentration of trace element, major element and physical parameters in the water resources; surface and ground waters are

shown in table 4.2 respectively. While the results of physico-chemical parameters of various water sources, surface and ground water in the study area are summarize into minimum, maximum,

mean, range, standard deviation, and variance, and their comparison with World Health Organization [who] Standard for drinking water is Presented in table 4.3 and the Geostatistics of physical and chemical parameters.

Sample L₁ represent Water Board [WB] sample L₂,L₃,L₄,L₅,L₆,L₉,L₁₂,and L₁₄ represent Borehole [Hand Pump and Motorized Borehole],Sample L₇,L₈,L₁₀,L₁₁,and L₁₃ represent Hand Dug Well Water [HDWW], sample L₁₅ represent Stream water [SW].

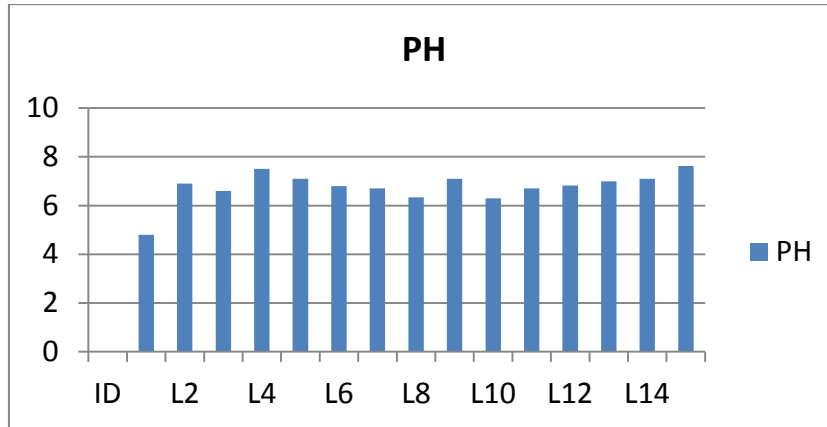


Fig.3: pH against sampling point.

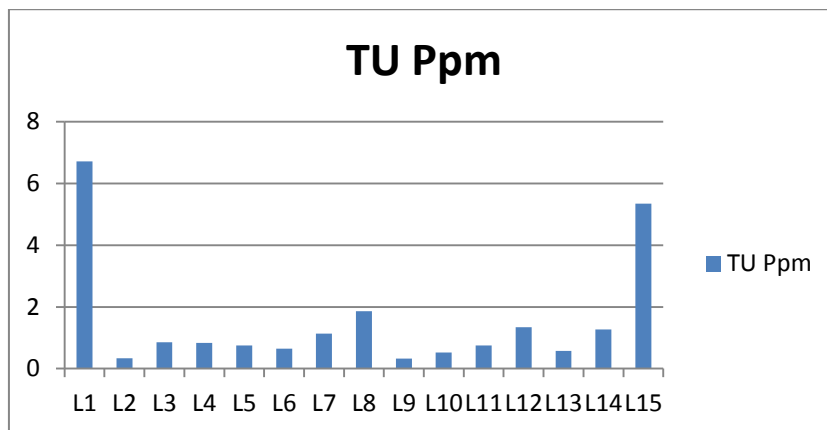


Fig.4: TU against sampling point.

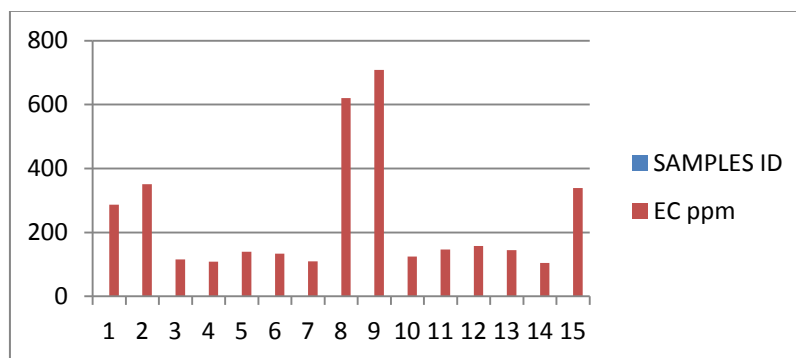


Fig.5: EC against Sampling points

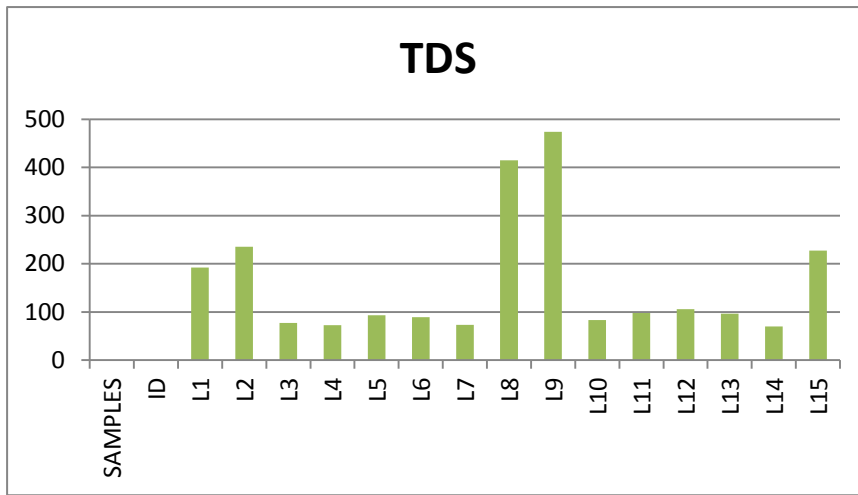


Fig.6: TDS against sampling point

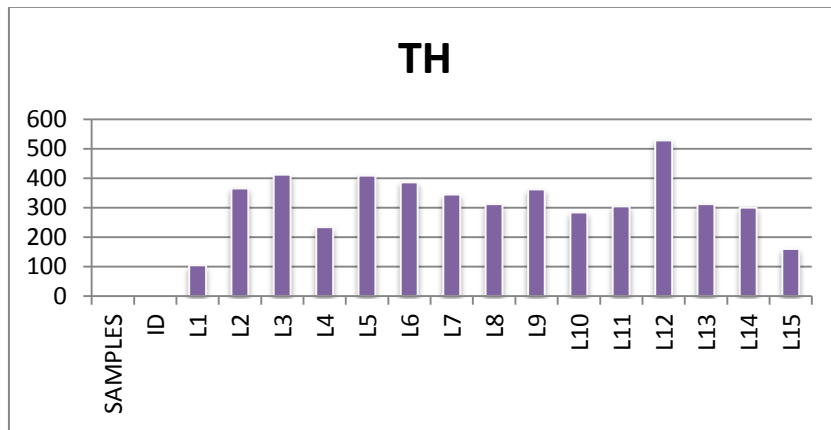


Fig.7: TH against sampling point

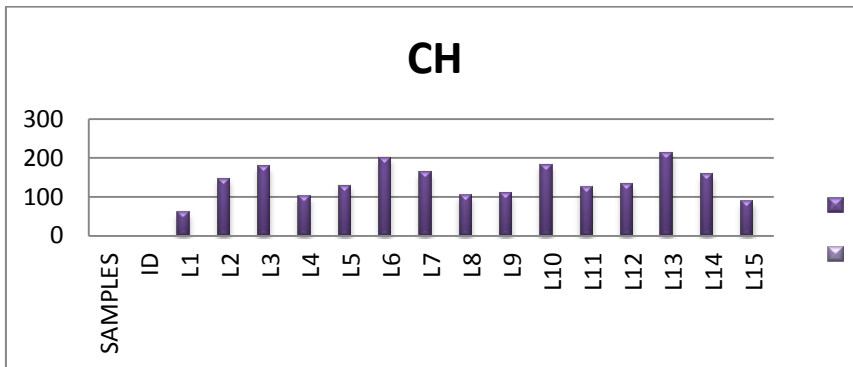


Fig.8: CH against sampling point

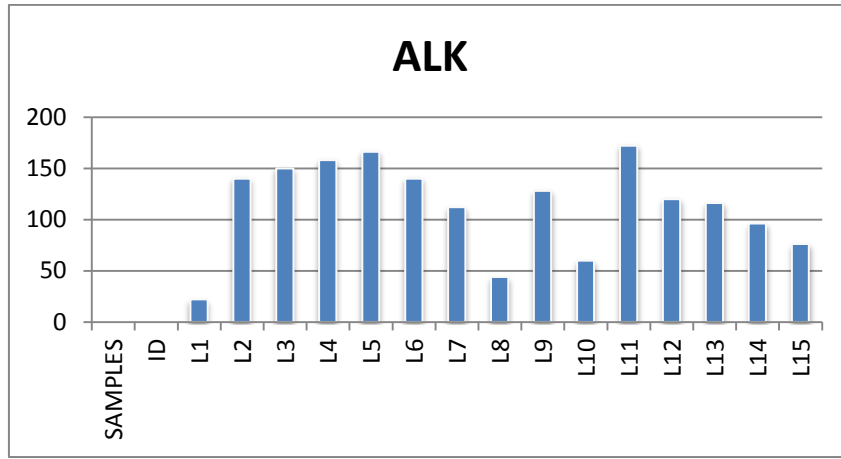


Fig.9: ALK against sampling point

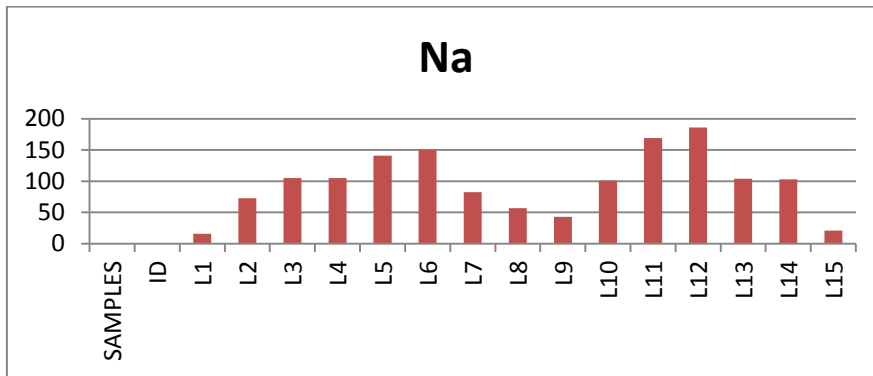


Fig.10: Na against sampling point

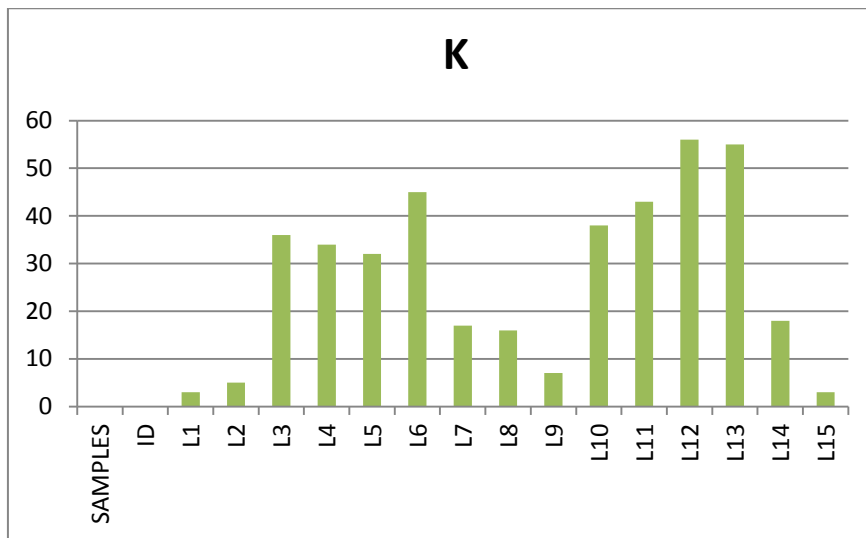


Fig.11: K against sampling point.

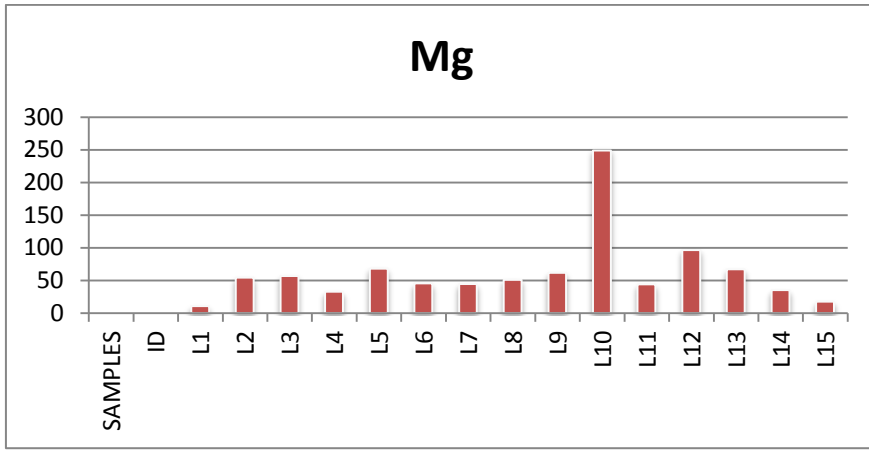


Fig.12: Mg against sampling point

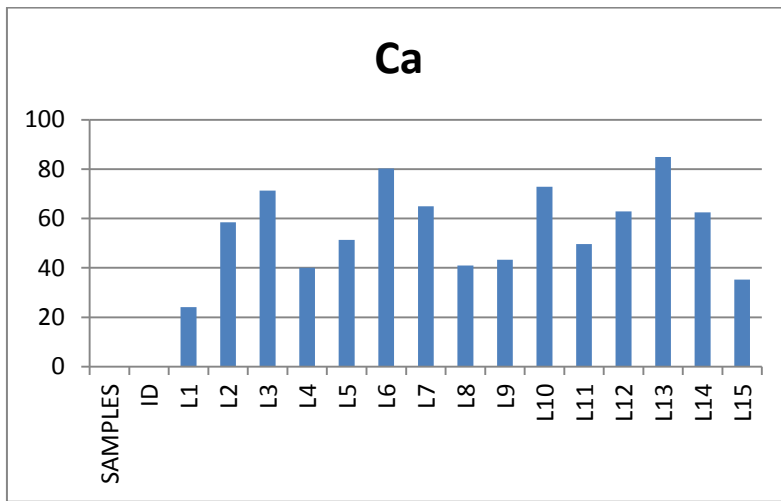


Fig.13: Ca against sampling point

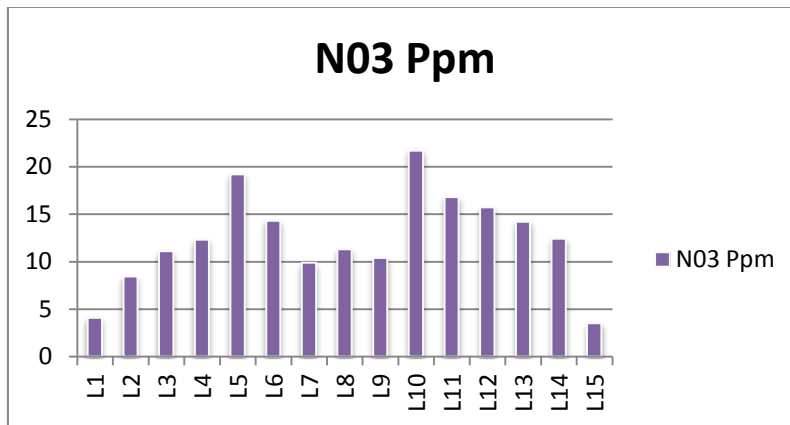


Fig.14: NO₃ against sampling point.

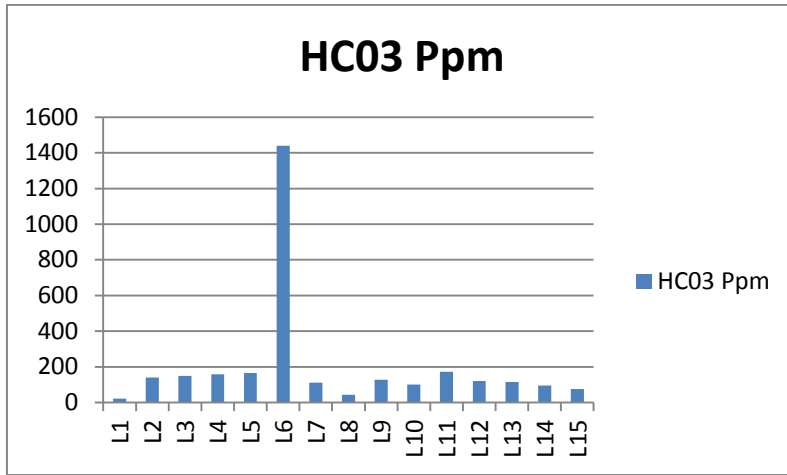


Fig.15: HCO₃ against sampling point

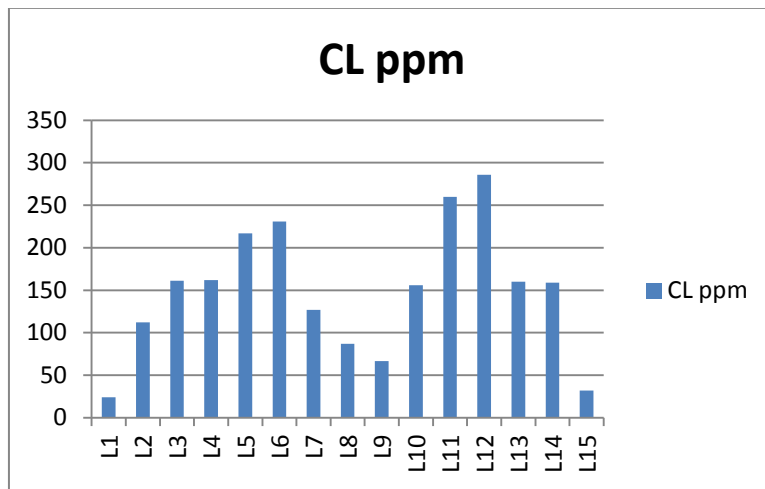


FIG.16: Cl against sampling point

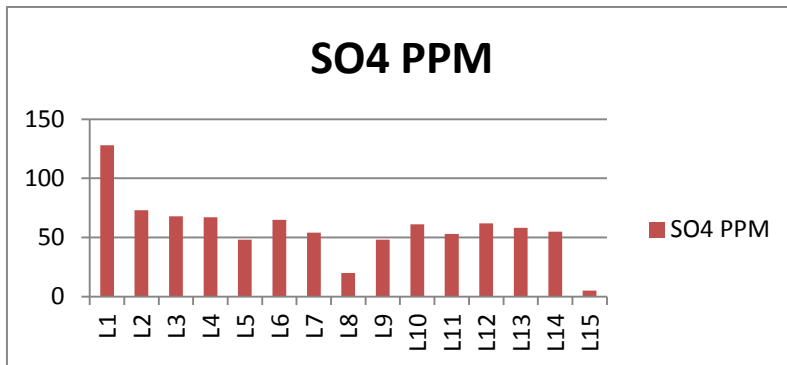


Fig.17: SO₄ against sampling point

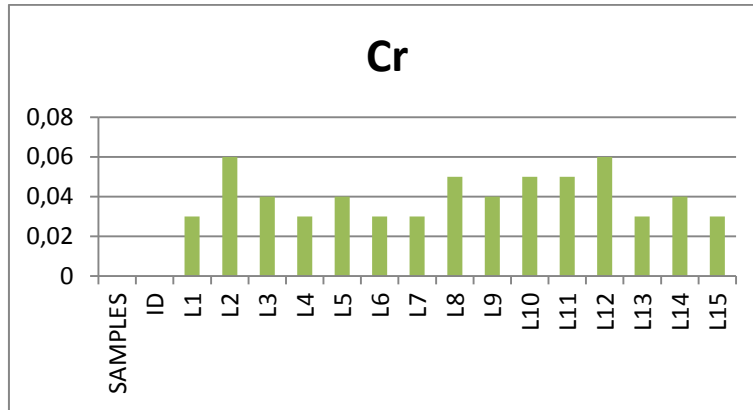


Fig.18: Cr against sampling point

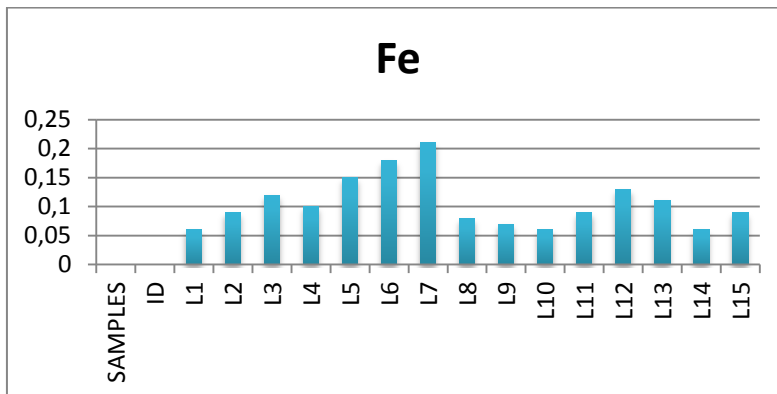


Fig.19: Fe against sampling point

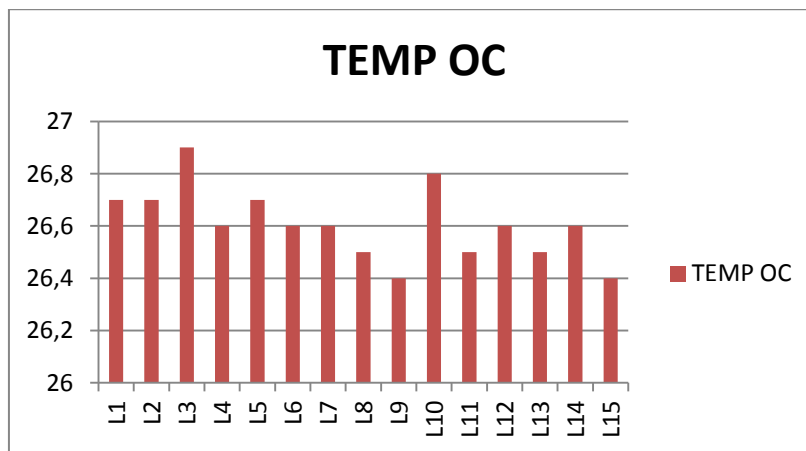


Fig.20: Temperature against sampling point.

Results and Discussion

The result of physico-chemical parameters of 15 various water samples (motorized boreholes, hand dug wells and surface waters samples were summarized in table 2 and fig.3 – 19.

The minimum and average temperatures of water are 26.4 °C and 26.9 °C respectively while the average temperature was 26.0 oc. The pH of water ranges range from 4.8 – 7.6 while the WHO permissible range is 6.5 – 8.5. The acidic nature of

borehole water near the NEPA road Okene may be attributed to seepage from refuse dump near the earth dam reservoir which supplied the water board in the area.

The electrical conductivity as shown in table 2 has an average value of 235 μ ohms/s which falls below the WHO recommended value of 750 μ ohms/s for good quality water. Also the mean value of total dissolves solid is 160.0 mg/l which

indicated fresh water. This is far below the WHO recommended value of 500 mg/l.

The water in the area is hard, since the total hardness was 528. It has minimum Ca hardness of 160 and maximum hardness of 200. The minimum hardness of Mg is 44.0 while its maximum hardness is 352.0, this indicated that the water is hard with respect to Mg and this is a permanent hardness.

The minimum and maximum concentration of NO_3 as shown in fig. 14 are 4.10 mg/l and 21.7 mg/l respectively which are for below the WHO recommended value of 50 mg/l for safe drinking water. The concentration of Fe in boreholes, hand dug wells and surface water in the area is less than 0.3 mg/l which is the maximum permissible limit. Fig.9 shows the Alkalinity in the various water samples which range between 22.0 and 271.0 mg/l and its mean value is 13.33 mg/l. The average concentration of Mn as shown in table 2 is 0.02 mg/l as against the 0.03 mg/l recommended by WHO for quality drinking water. The hand dug well at Idogido has Ca concentration of 80.2 mg/l which is above the WHO recommended maximum permissible limit of 75.0 mg/l, while other sources of water have their Ca concentration below this value. The WHO permissible of Mg for safe quality water is 50 – 200 mg/l, while the average value of Mg is 47.4 mg/l which is still within this range. The mean concentration of SO_4 as shown in table 2 is 97.2 mg/l which is within the WHO range of 100 – 200 mg/l. The average of Cl ion is 149.4 mg/l which is lesser than 250 mg/l in quality drinking water. The lowest and highest concentration of Na as shown in fig.10 are 15.5 186.0 mg/l respectively and these values cannot have any adverse effect on the quality of water. The mean concentration of bicarbonates 113.33 mg/l with standard deviation of 42.61 while the WHO recommended value is 200 mg/l. The range of K is 3.0 – 56 mg/l which are within the 100 mg/l recommended for good quality drinking water. The concentration of arsenic which one of the trace elements analyzed in the area is zero.

The highest concentration of Cr of 0.06 mg/l was obtained from motorized borehole around NEPA road, Okene and hand dug well around Inike which are above the 0.05 mg/l recommended by the WHO. This may be the result of seepages from refuse dump site close to the borehole.

Conclusion

The results of the analysis have shown that the values of the physical parameters such as temperatures, total dissolved solids (TDS), electrical conductivity (EC), are within the WHO recommended standard for safe drinking water. The pH of 4.8 was obtained at one borehole water point, while the other water points have values within the range of 6.5 – 8.5 recommended by WHO for quality water standard. The water in the area was hard due to the high concentration of Mg. The concentration of NO_3 , Fe, Mn, Ca, Mn, SO_4 , Cl, Na, HCO_3 , K, As and Cr are within the WHO standard for safe drinking water.

Reference

1. Turner, D.C., Macleod W.N., Buchanan, M.S. (1971): The Geology of Jos Plateau. Geol. Surv. Of Nig. Bulletin 32, vol.2 Pg.107.
2. World Health Organization (2014): Standard for Water Quality