PHYSICO - CHEMICAL AND BACTERIOLOGICAL ANALYSIS OF GROUNDWATER IN KATAEREGI AND ENVIRONS KATCHA AND BOSSO L.G.AS OF NIGER STATE

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Abstract

The physico - chemical and bacteriological parameters of the groundwater from ten locations at Kataeregi and its environs" in Katcha and Bosso local government areas of Niger State were determined using standard analytical methods. Results obtained show that all the parameters are below the recommended permissible value by World Health Organization (WHO) and Nigeria Standard for Drinking Water Quality (NSDWQ). The bactoriological analysis for location1,3,5,6,7,8 and 10 shows values higher than the permissible recommended value of WHO and NSDWQ except for locations 2, 4, 6 and 9 recorded zero E.coli. Three main water types were identified namely; Sulphatic water type of the normal earth alkaline water which is the most dominant, So_4 type of the earth alkaline with higher alkaline proportion, and Predominantly $HCO_3 + So_4$ type also of the normal earth alkaline water. Thin section analysis shows that the basement rock in part of the area is granite.

Introduction

The usefulness of groundwater for various applications to a great extent depends on its physical, chemical and bacteriological composition; consequently, major agencies charged with public health services, like the World Health Organization (WHO,1983)and Nigerian Industrial Standard (NIS, 2007) have set up various permissible standards for water usage. The term water chemistry or water quality refers to the qualities of these substances (commonly called solutes) that are present in a particular water sample, making up its chemical composition (Plummer et al, 2003).

The chemistry of groundwater is controlled by factors such as hydrology and hydrogeology, the type of aquifer, the mode and source of recharge, the drainage area, and the permeability of the zone of aeration (Amadi et al, 2006). Several groundwater development schemes have been executed in the area of study including boreholes and handdug wells with little or no attention paid to the geochemical characteristics of the water and its suitability for specific or general purposes. Ground water contains various amount and types of impurities that can be introduced through weathering of rocks and leaching of soils, dissolution of aerosol particles from the atmosphere and several anthropogenic activities, such as mining, agricultural and poor hygienic practices (Ipinmoroti and Oshodi 1993; Asaolu et al , 1997; Adefemi and Awokunmi, 2010). Kataeregi and the neighboring villages in Niger faces a lot of water shortage like most other communities in the state and Nigeria. Government and some individual have resulted to ground water development and extraction mostly for domestic uses with little or no attention paid to their physic- chemical and microbial charracteritics. The present study represents an attempt aimed at the hydrogeochemical and microbial assessment of groundwater quality in Kataeregi and environs in Niger state, Nigeria and their suitability for various purposes. In the present study both handdug wells, boreholes and a river water samples were examined and analyzed.

The study area

The study area lies along Minna/Bida road between latitude 09°18'52.2"N-09°23'11.4"N and longitude 006° 12'57.0"E-006° 20'50.1"E, covering a distance of about 14.5 km. This include Kateregi axis of the road and the adjoining villages (Maraya, Sabon Fegi, Sabon Yeregi and Gadda village) all being accessible through the Minna/Bida road which is the only major road in the area. Sample 1 from a river, samples 2,4,6 and 9 are from boreholes while samples 3,5,7,8 and 10 are from Handdug wells.

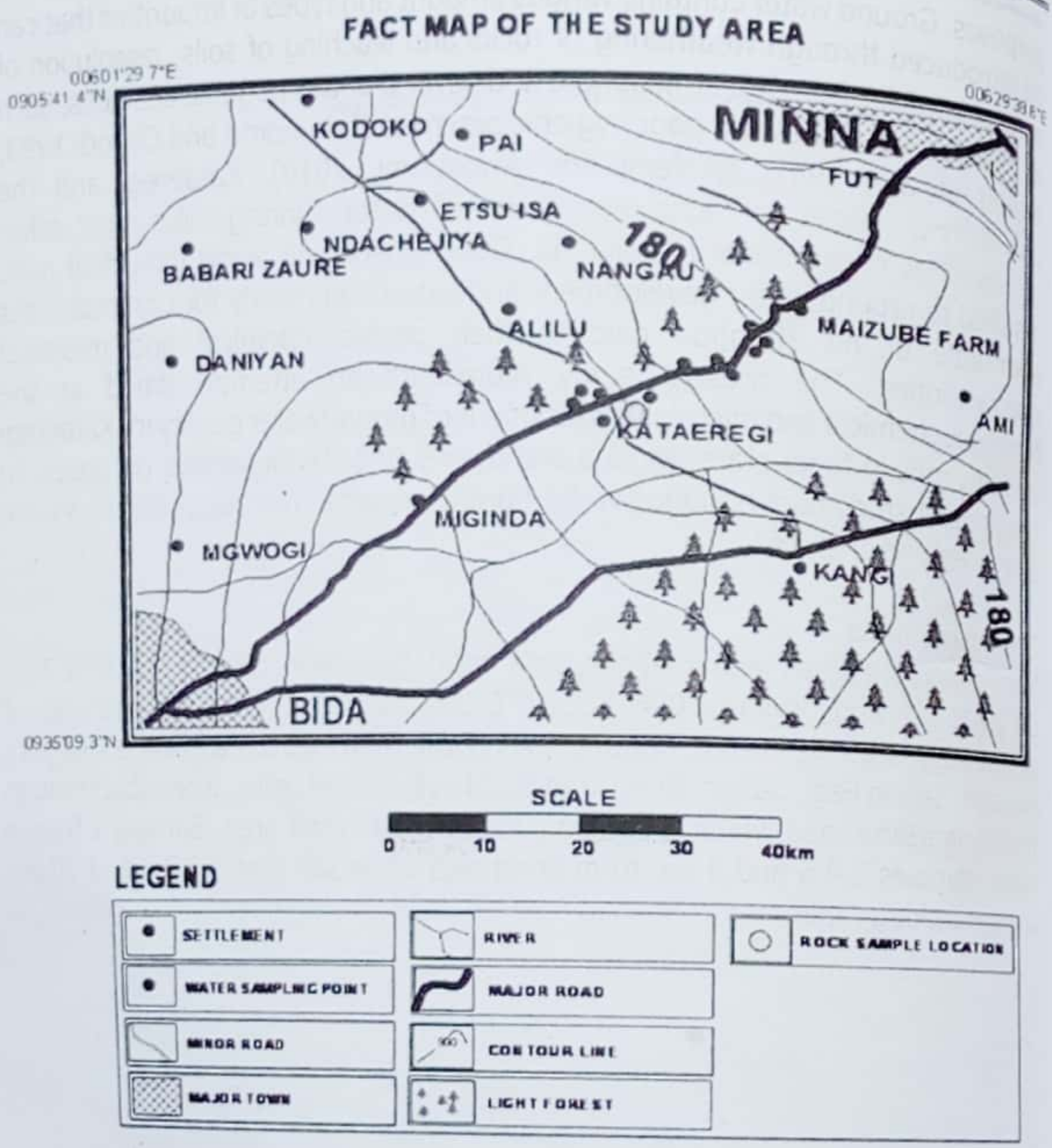

Figure 1: Facts and topographic map of the study area

Relief and Drainage Pattern

The drainage pattern of the study area can be linked with the type of climatic condition of the area and a major river, with some other seasonal rivers in which only few of them sustain water during dry season. The area is of basically low land area with some occasional high ferruginized ridges area in some parts. The drainage pattern is mainly dendritic as is typical of granitic environment (Clive 1991).

Geology of the Study Area

Ajibade et.al (1979), Truswell and Cope (1963) and Russ (1957) have shown that the area is part of the Basement complex of Nigeria. About ninety percent of the area falls within the Basement Complex rocks of Nigeria consisting of gneissic granites, schist and amphibolites schist. The rocks are granitic in nature and have undergone fracturing and weathering. The remaining ten percent of the area is within the contact zone between the Basement and the Bida Sand Stone Formation.

Sampling and Sample Preservation

The study involved both field activities and laboratory analysis. The field analysis includes; collection of water samples and in-situ measurement of physical parameters such as pH, electric conductivity, temperature using Wagtech JMP kit (WGpH 3), and H1935005 MIcroprocessor and Wagtech H198311 conductivity meter. Water samples were collected according to normal guide lines and tested at the Federal Ministry of Water Resources Regional Water Quality Laboratory, Minna for chemical analysis. Ethyline Diamine Tetra Acetic acid (EDTA) Titeimetric method was used to determine Calcium and Magnesium, Turbidimetric method using CHROMA colorimeter (252) for Sulphate and Nitrate, Flame Photometric for Potasium and Sodium, Phanethroline for Iron while the Membrane filtration method was used for the determination of the Total Coliform and E-Coli.A total of ten (10) samples were collected during in the month of April 2011.

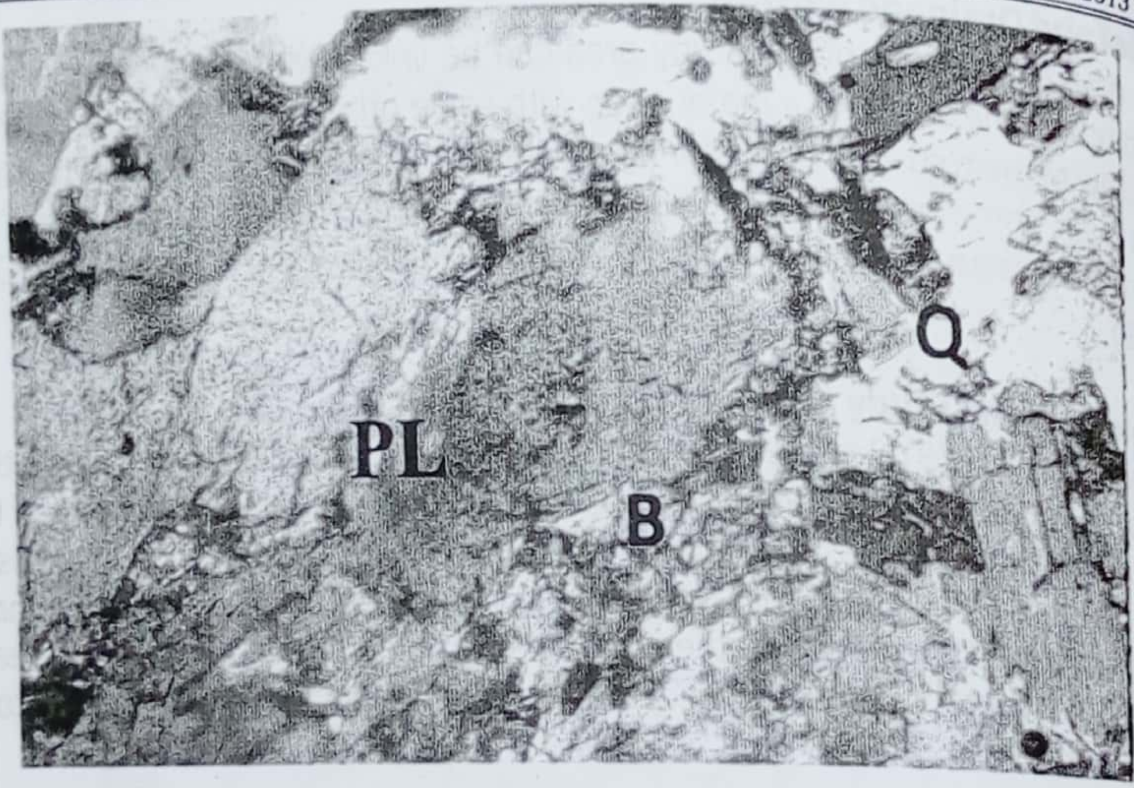

Plate 1: Photomicrograph of the rock found in the area under cross polarized light (Q: quartz; B: biotite and PL: plagioclase)

Table 1: Physical parameters of groundwater samples from Kataeregi Area

S/N	PARAMETER	NIT	SAM 1	SAM	SAM 3	SAM 4	SAM 5	SAM 6	SAM 7	SA M 8	SAM 9	SA M 10	WH O	NSDWQ S
1	P^H		8.51	7.9	7.7	8.33	7.49	8.68	8.33	9	9.37	9.51	6.5-8.5	6.5-8.5
2	Elect. Conductivity	µS/cm	48	21	143	180	20	127	117	241	315	416	1000	1000
3	TDS	mg/l	32.2	14.07	99.16	120.6	13.4	85.1	78.4	161.5	211.1	278.7	500	500
4	Dissolved oxygen	mg/l	7.95	5.55	10.15	10.28	5.5	9.45	8.06	10.89	11.3	11.2		
5	Alkalinity	mg/l	35	6	23	49	8	43	23	62	76	37		
6	Hardness	mg/l	28.02	13.02	173.2	73.1	126.1	90.1	58.1	28	141.1	129.1	150	150
7	Turbitity	NTU	0.8	4.52	9.7	0.87	3.62	0.78	3.17	1.01	1.03	0.99	5	5

Table 2: Major Ions and Microbial Parameters Analyzedin Kataeregi Area Compared with W.H.O and NSDWQ Standard

S/N	ION	Sam1	Sam2	Sam3	Sam4	Sam5	Sam6	Sam7	Sam8	Sam9	Sam10	W.H.O	NSDWQ
1	Calcium	15.6	3.21	12	18.9	6.02	11.23	11.63	23.3	29.28	27.27	75	75
2	Magnesium	2.68	1.22	26.13	3.17	0.97	4.15	2.93	7.57	13.53	20.51	150	150
3	Sodium	15.6	3.21	12.03	18.9	6.02	11.23	11.63	23.3	29.28	27.27	200	200
4	Potassium	0.67	3.35	7.4	10.7	0.67	10.05	7.37	12.1	14.74	18.09	20	20
5	Bicarbonate	35	6	23	49	8	43	23	62	76	37	120	120
6	Sulfate	0	39	1	2	1	1	3	0	1	6	100	100
7	Chloride	32	31.5	39	29.5	50.98	40.98	23.99	29	37.98	28.49	250	250
8	Nitrate	1.06	1.06	1.6	1.06	1.59	1.59	1.06	1.59	1.06	1.06	50	50
9	E-Coli (cfu/100ml)	22	0	76	0	8	0	29	75	0	20	0	0
10	Coliform (cfu/ml)	125	4	202	6	49	15	108	192	9	172	10	10

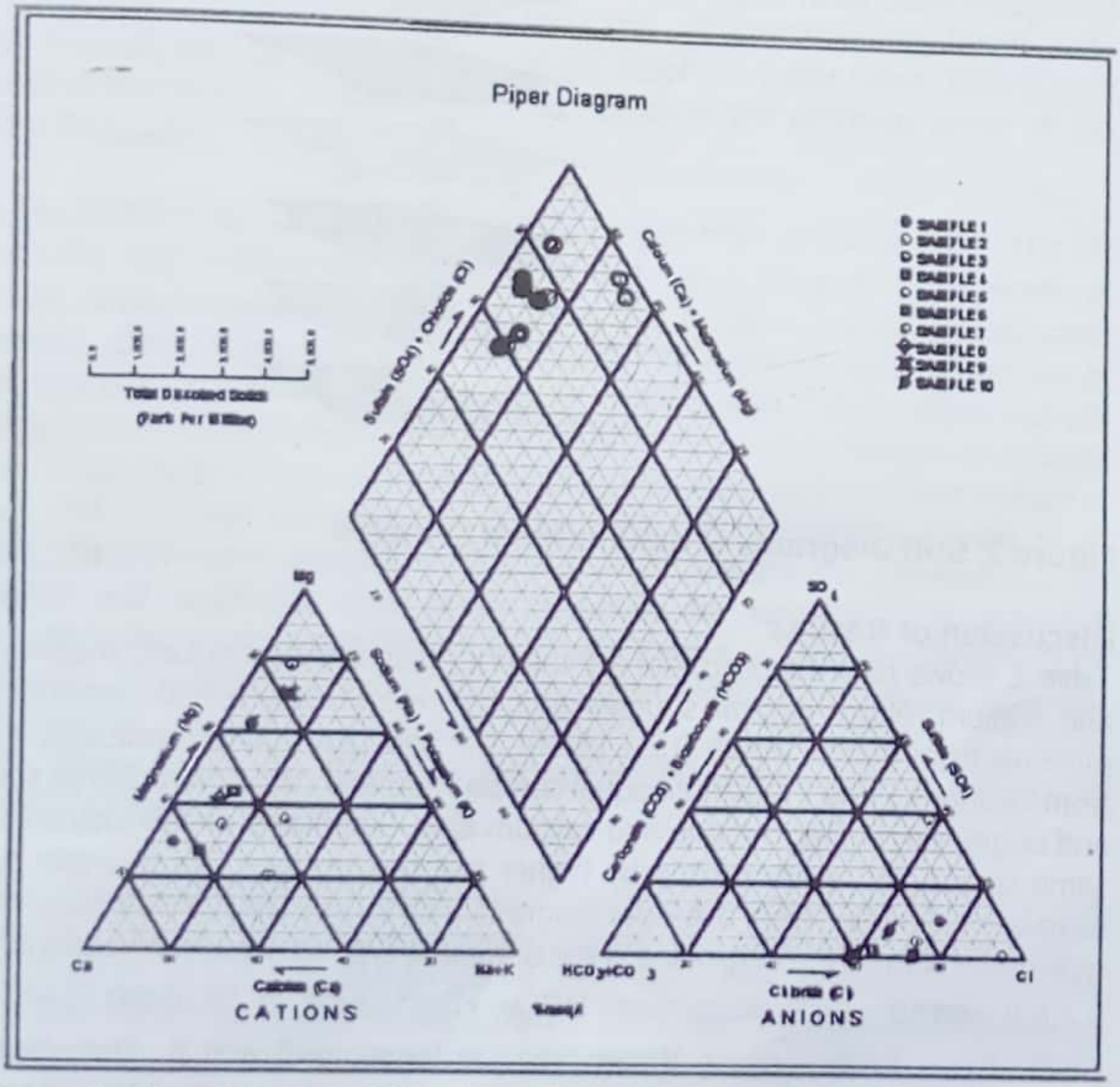

Figure 2: Piper Diagram Showing All the Analyzed Water Samples

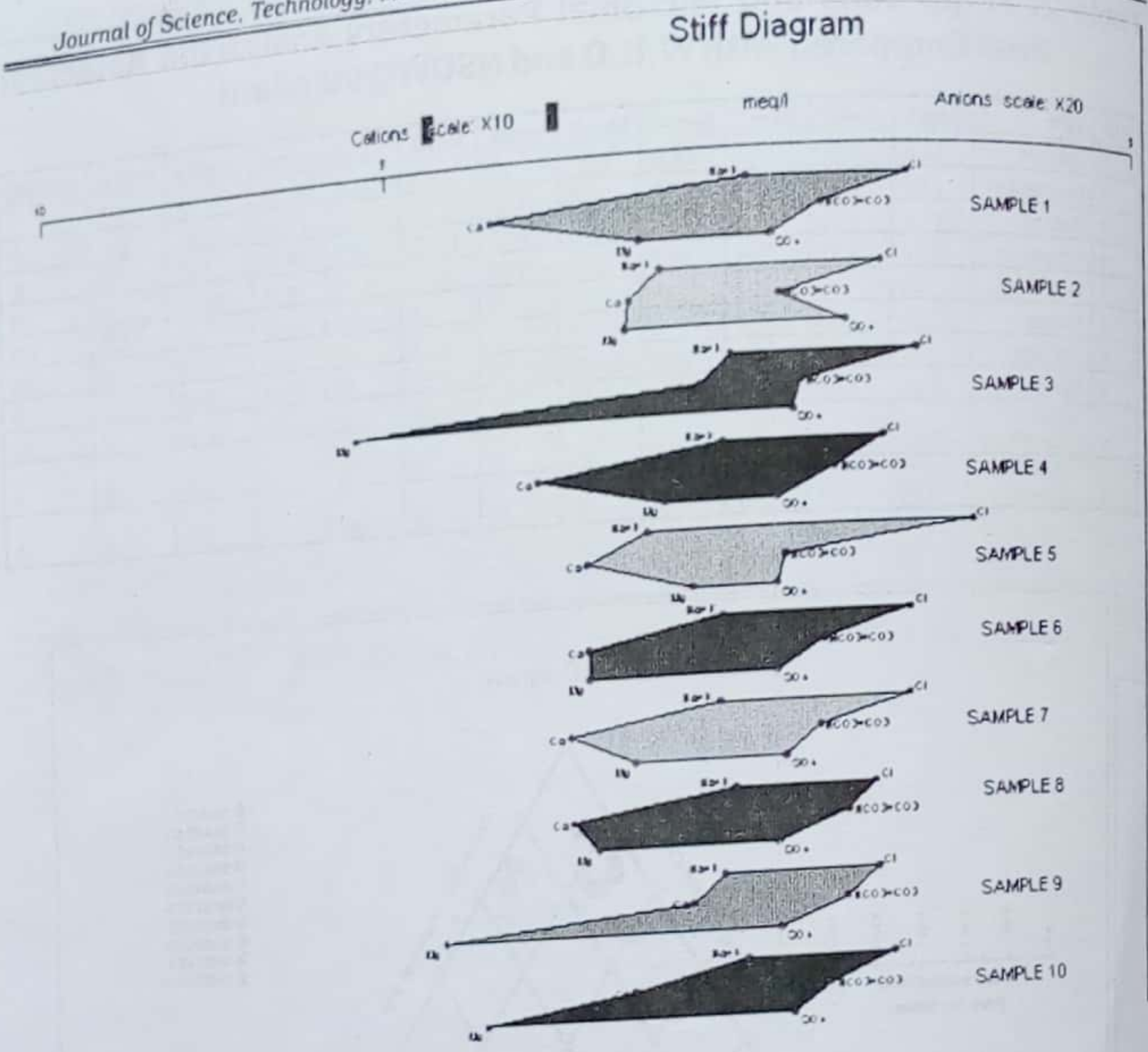

Figure 3: Stiff Diagrams of the Analyzed Samples

Discussion of Results

Table 2 shows high concentration of chloride, followed by calcium, magnesium and sodium. Major natural sources of these elements are feldsparsand clay minerals from granitic rocks (Hen 1970). The stiff plot figure 2 indicates water from locations 5 and 7 of almost equal composition and common recharge source and origin with higher chloride and calcium ions. Samples 9 and10 indicates the same source and characterized by higher magnesium ions. Three water types have been identified from the Piper diagram in fig1.They are the *Sulphatic Water type* under Normal Earth Alkaline is the dominant type as seen from location 1, 2, 3,4,6,9, and 10, the Predominantly HCO_3 $+So_4^{2}$ type in locations 8, and the So_4^{2} type Earth Alkaline Water type in locations 5 and 6. The chemical composition of water depends considerably on the geological formation it comes from and in contact with, during its migration. The majority of the analyzed water broadly falls under normal earth alkaline water (Ca^{2} , Mg^{2}). These elements might have dissolved into water through weathering of granitic rocks to clay minerals. Hardness of water results from the presence of divalent metallic cations of which calcium and magnesium are the most abundant in ground water Magnesium in groundwater from igneous rock primarily derives from ferromagnesian minerals like olivine, pyroxenes, amphiboles and dark coloured micas (Herman, 1978). The bicarbonates, sulphate and potassium have a slightly higher concentration than the carbonates which occur more or less as trace elements in water. All the analyzed water are soft and domestically useful (Hem 1970 WHO and NSDWQS).

Also, the stiff plot indicates water of almost equal composition of probably common recharge source and origin. Three water types have been recognized from the result of the piper diagram, they are: (i) predominantly bicarbonate water type (ii) bicarbonate-sulphate and (iii) Sulphatic water types. Idris (2010) identified bicarbonate and sulphate water types in the northern sector of the Middle Bida Basin.

The temperature of the analysed samples ranges from 27.0°C to 31°C. The pH values affect the mobility of most elements. Only Na, K, No_3 and Cl^- ions remain in solution through the entire range of pH values found in normal groundwater (Offodile, 2002). Therefore, water of very low pH carries high concentration of ferric and ferrous ions. Ferrous ions remain stable under this condition and will oxidize to ferric ion at high pH . Temperature has influence on the taste of drinking water. Water for drinking purpose has a better fresh taste at lower temperature of about 15°C but high temperatures do not imply impurities (Olasehinde et al, 2003). The pH value ranges from 7.49 to 9.51 which is within the permissible limits of WHO and NSDWQS .The range of values for turbitity, TDS, electrical conductivity and hardness as indicated on Table 2 were; 0.78NTU – 4.52NTU, 13.4 – 278 mg/l ,20 – 416us/cm and 13.02 – 173.2mg/l. Most natural ground water has pH within the range of 6 – 8.5 and a TDS of between 100 – 10000mg/l (Hem 1970). These values are all within the permissible limits of WHO (1984) and NSDWQS (2007).

Table 2 shows the result of the chemical parameters from the ten locations. The values for calcium, magnesium, sodium, potassium and bicarbonate are 3.21-29.28,0.97-26.13,3.21-29.28,0.67-18.09 mg/l while that of sulphate, chloride and nitrate were 0-39, 23.99-50.98, 1.06-1.6 and 6-76. The mean values of these parameters are within the permissible limits of WHO (1994) and NSDWQS (2007) as shown on Table 2. Chlorine is very important in potable water as it gives a measure of protection against any contamination that may occur. Chloride ion is relatively lower in comparism with WHO and NSDWQS maximum value of (200 - 600mg/l).The low concentration of this ion in these water samples implies that they can not be kept for a long period before their intake because there are chances of them being polluted .

The values of E. Coliform ranges from 0/100cfu/ml to 76/100cfu/ml, while the value of total coliform ranges from 4 cfu/ml to 202/m as observed from Table 2. NSDWQS provides for zero microbial requirement for E-coli only location 2, 4,6 and 9 conform with. Location 2,4 and 9 only conform with the total Coliform count of permissible level of 10 cfu/ml. The highest total Coliform value of 202 cfu/ml was recorded at location 3. Only locations 2,4 and 6 conform with the physic - chemical and bacteriological permissible requirements set by NSDWQS and WHO.

Conclusion

The chemical composition of the water reveals that the tested water samples are predominantly bicarbonate water. The characteristics of the group are very low concentration of sodium, calcium and total dissolve solid, yet sodium and calcium are relatively higher in concentration than the other cations. This could be traced to the granitic background of the aquifer.

The E-coliform with the exception of location2, 4,6 and 9 are unfavourable while the Total Coliform are far above the 10cfu/ml recommended with the exception of location 2,4 and 9 .

The water quality might need improvement through adequate treatment and security measures to reduce anthropogenic influence on the water quality should be considered.

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