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PHYSICOCHEMICAL ANALYSIS OF GROUNDWATER SAMPLES OF GWOZA TOWN AND ENVIRONS, NORTHEASTERN NIGERIA.

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ABSTRACT

The study was carried out to assess the impacts of human activities on the groundwater quality in Gwoza town and Environs Northeastern Nigeria. The quality was assessed in terms of physicochemical parameters. Groundwater water samples were collected from seven (7) villages in the study area during December 2008- February 2009. The physicochemical parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), Calcium (Ca2+), magnesium (Mg2+), Sodium (Na+), Potassium (K+), Chloride (Cl-), Nitrate (NO3-), Sulphate (SO4 2-) and bicarbonate were analyzed to know the present status of the groundwater quality. The results were compared W.H.O standard (2013). It was found that the underground water was fresh to moderately hard at some sampling sites. The remaining sampling sites shows physicochemical parameters within the water quality standards and the quality of water is good and it is fit for drinking purpose.

Keywords: ground water, geology, physicochemical properties

INTRODUCTION

Groundwater is used for agricultural, industrial, household, recreational and environmental activities all over the world. In the last few decades, there has been a tremendous increase in the demand for fresh water due to rapid growth of population and the accelerated pace of industrialization. The quality of water is vital concern for mankind since it is directly linked with human welfare. In Nigeria, most of the population is dependent on groundwater as the only source of drinking water supply. Potable water is the water that is free from disease producing microorganisms and chemical substances that are dangerous to health, Shittu (2008). Majority of the rural common people do not have access to potable water and therefore, depend on well, stream and river water for domestic use. The story of each city may be different, but the main reasons for the water crisis are common, such as, increasing demand, zonal disparity in distribution of water supply, lack of ethical framework, inadequate knowledge and resources, major land-use changes, long term water level declines, increase in salinity and pollution.

Groundwater is generally considered as a safe source of fresh drinking water. But the wells are generally considered as the worst type of groundwater sources in the term of physiochemical contamination due to the lack of concrete plinth and surrounding drainage system W.H.O, (2009). The reason for elucidation of important parameters in water quality assessment may be attributed to the fact that in the overall portability of water, such parameters should not be ignored Altman (1995). The porphyritic granites in the study area are coarse to very coarse grained with large white or pink phenocrysts of microcline while the biotite granite has granular texture with wide range of grain sizes (Rahman, 1976 and Van Bareeman et al; 1977). Sulphate, if present in sufficient quantities will impact a bitter taste to water and may also be cathartic (Todd, 1980). There are various ways as ground water is contaminated such as use of fertilizer in farming, seepage from effluent bearing water body. Once the groundwater is contaminated, its quality cannot be restored by stopping the pollutants from the source. Low values of cation/anion which suggest minimal pollution due to sewage effluent and lack of indiscriminate waste disposal accompanied by low usage of fertilizer (Sadashivaiah, 2008). It therefore becomes imperative to regularly monitor the quality of groundwater and to device ways and means to protect it.

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AIM AND OBJECTIVES

The objective of this study is to investigate qualitative analysis of some physicochemical parameters of groundwater in study area.

STUDY AREA

Gwoza is situated at northeastern part of Nigeria lying between latitude 11° ' N and 11° 08'E and longitude 13° 33'E and 13° 47'E (Fig.1). Bore hole/Hand dug wells are generally used for drinking and irrigation purposes in this district. Waste disposal and farming activity are the two key reasons for deterioration of water quality in the study area; the sampling locations are given in fig1.

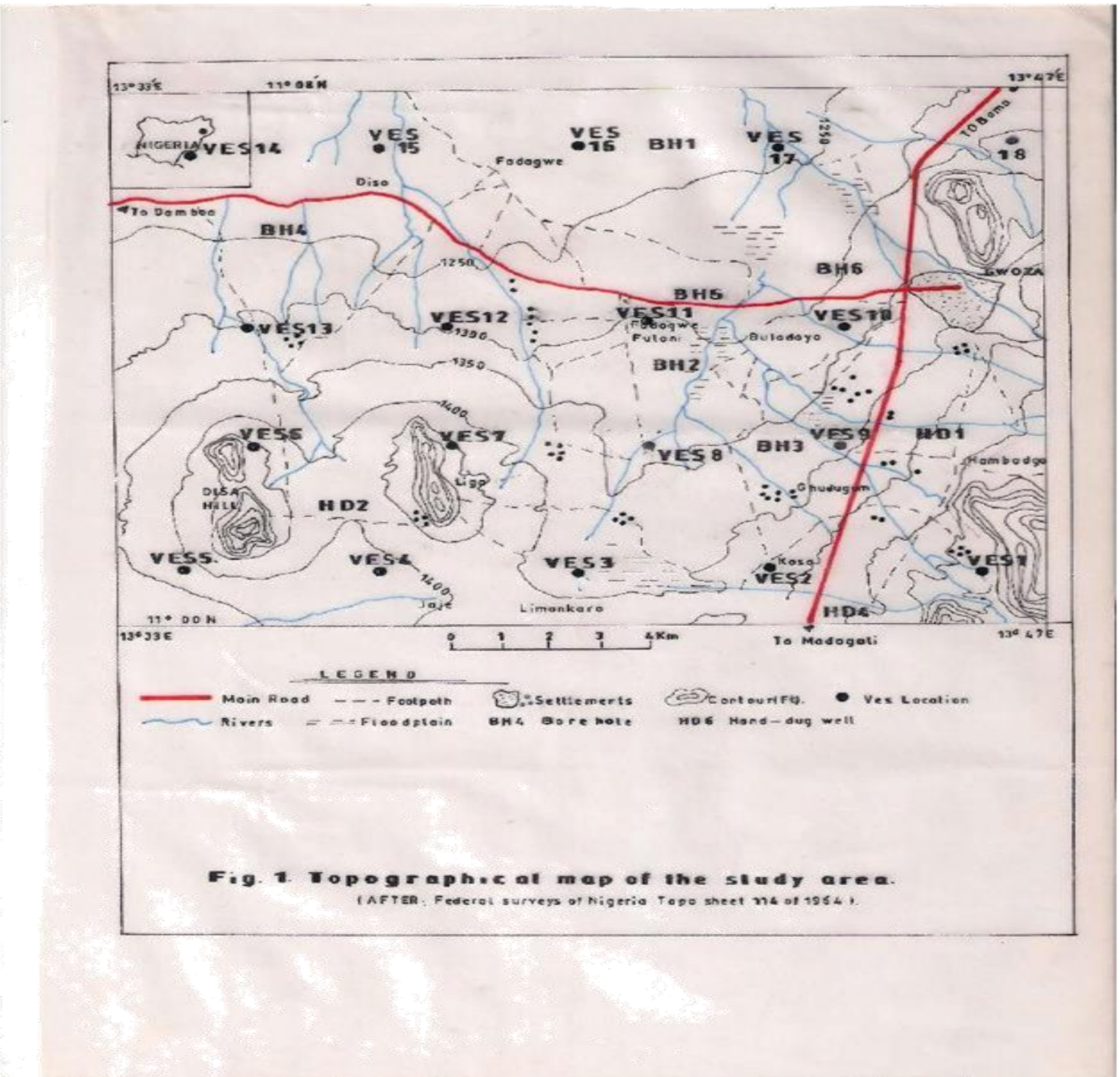

Fig. 1. Topographical map of the study area.
(AFTER: Federal surveys of Nigeria Topo sheet 114 of 1964).

MATERIALS AND METHODS

Groundwater samples were collected in a pre cleaned polythene bottles from 6 (six) boreholes and 4 (four) hand dug wells during dry season (February to March) 2011 for analysis of chemical characteristics. Chemical analyses were carried out for the major ion concentrations of the water samples collected from different locations using the standard procedures recommended by APHA. The analytical data can be used for classification of water for utilization purposes and for ascertaining various factors on which the chemical characteristics of the water depend (Todd 1980).

Samples were analyzed for different physicochemical parameters such as, pH, electrical conductivity (EC), total dissolved solids (TDS), Calcium ($Ca2+$), magnesium ($Mg2+$), Sodium ($Na+$), Potassium ($K+$), Chloride ($Cl-$), Nitrate ($NO3$ -), Sulphate ($SO4$ 2-) as per standard procedures (APHA, Standard methods). The quality of groundwater has been assessed by comparing each parameter with the standard desirable limit of that parameter in drinking water as prescribed by W.H.O (2009). The simple linear correlation analysis has been carried out to find out correlation between two tested parameters.

RESULTS AND DISCUSSION

Maximum and minimum concentration of major iron present in the groundwater from the study area is presented in table 1. The Piper trillinear is used to infer hydro geochemical facies. These plots include two triangles, one for plotting cations and the other for plotting anions. The cation and anion fields are combined to show a single point on the diamond-shaped field, from which inference is drawn on the basis of hydro geochemical facies concept. These tri-linear diagrams are useful in bringing out chemical relationship among groundwater samples in more define terms rather than with other possible plotting methods (fig 2).

The average results of the physicochemical parameters for water samples are presented in Table 2.

TEMPERATURE

The result obtained shows an average temperature of the borehole wells as 34.20c and that of hand dug wells as 37.20c which is in agreement with the W. H. O. (2009).

PH

The result obtained from analysis of 10 water samples collected revealed an average PH of 6.9 in the boreholes and 6.8 for the hand dug wells, which is within the W. H. O. (2009) accepted limit of 6.5 to 8.5.

ELECTRICAL CONDUCTANCE

Electrical conduction has an average value of 239µs/cm in the boreholes and 389µs/cm in the hand dug wells and the W. H. O. (2009) has a range of 180-500µs/cm.

TOTAL DISSOLVE SOLIDS

TDS has an average value of 253mg/l in boreholes and hand dug wells have an average value of248.3mg/l, they fall within the accepted limit of 100 – 500mg/l of W. H. O. (2009).

CATIONS:

Sodium has an average value of 0.36mg/l in the borehole wells while an average value of 0.27mg/l is for the hand dug wells, they all fall within the standard limit of 0.1 – 1.0mg/l of W. H. O. (2009).

Potassium has an average value of 5.9mg/l in borehole wells and hand dug wells have an average value of 8.45mg/l and they fall within the standard limit of 1 – 25mg/l of W. H. O. (2009).

Calcium has an average value of 15.5mg/l in borehole wells and hand dug wells have an average value of 22.3mg/l and they fall within the standard limit of 10 – 75mg/l of W. H. O. (2009).

Magnesium has an average value of 10.6mg/l in borehole wells and hand dug wells have an average value of 11.8mg/l and they fall within the standard limit of 1 – 50mg/l of W. H. O. (2009).

Iron has an average value of 0.16mg/l in borehole wells and hand dug wells have an average value of 0.08mg/l and they fall within the standard limit of 0.3 – 1.0mg/l of W. H. O. (2009).

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Table2: Analysis of geochemical Data of Water quality in Gwoza town and Environs

Well Type	**Chemical Parameters (Cations) Meq/l**				**Chemical Parameters (Anions) Meq/l**					
	Na	K	Ca	Mg	Cl	S0	HC03	**Hardness**	**Range**	**Water Class**
	0.55	**6**	**31**	**12**	**4**	**0.2**	**25**			**moderately**
BH1	*0.024*	*0.153*	*1.547*	*0.987*	*0.113*	*0.004*	*0.833*	126.7	76-150	**hard**
	0.7	4.2	42.3	27	3	0.1	22.8			
	0.45	**3.42**	**23.3**	**11.2**	**6.6**	**0.6**	**45**			**moderately**
BH2	*0.019*	*0.009*	*1.163*	*0.921*	*0.186*	*0.001*	*1.5*	104.17	76-150	**hard**
	0.5	0.2	30.6	24.2	4.9	0	39.5			
	0.29	**6.4**	**19**	**1.3**	**4.7**	**0.9**	**55**			
BH3	*0.013*	*0.164*	*0.948*	*1.107*	*0.133*	*0.019*	*1.833*	52.83	0-75	**Soft**
	0.4	5.3	30.7	35.8	4.3	0.6	59.3			
	0.04	**5**	**26**	**8.2**	**9**	**7.7**	**27**			**moderately**
BH4	*0.002*	*0.128*	*1.297*	*0.675*	*0.254*	*0.16*	*0.9*	98.62	76-150	**soft**
	0.1	3.7	38	19.7	7.4	4.7	26.3			
	0.3	**11**	**13.9**	**8.4**	**11.3**	**3.1**	**67**			
BH5	*0.013*	*0.281*	*0.694*	*0.691*	*0.319*	*0.065*	*2.233*	69.19	0-75	**Soft**
	0.3	6.5	16.2	16.1	7.4	1.5	51.9			
	0.53	**3.5**	**12**	**11**	**6.5**	**2.4**	**52**			**moderately**
BH6	*0.023*	*0.089*	*0.6*	*0.905*	*0.183*	*0.05*	*1.733*	90.2	76-150	**Soft**
	0.6	2.5	16.7	25.3	5.1	1.4	48.4			
	0.02	**8**	**28**	**14**	**4.2**	**9.2**	**39**			**Moderately**
HD1	*0.009*	*0.2*	*1.4*	*1.152*	*0.118*	*0.192*	*1.3*	127.4	76-150	**Soft**
	0	0.5	33.5	27.5	2.8	4.6	31.1			
	0.12	**4.4**	**19**	**7.9**	**3.7**	**3.4**	**28**			**Moderately**
HD2	*0.005*	*0.011*	*0.948*	*0.65*	*0.104*	*0.071*	*0.933*	79.89	76-150	**Soft**
	0.2	0.4	34.8	23.9	3.8	2.6	34.3			
	0.12	**7.4**	**21**	**6**	**5.3**	**5**	**40**			
HD3	*0.005*	*0.189*	*1.046*	*0.494*	*0.15*	*0.104*	*1.333*	77.89	76-150	**Moderately**
	0.2	5.7	31.5	14.9	4.5	3.1	40.1			**Soft**
	0.82	**14**	**21**	**19.1**	**9**	**6.4**	**38.6**			
HD4	*0.036*	*0.358*	*1.046*	*1.57*	*0.254*	*0.133*	*1.267*	97.41	76-150	**Moderately**
	0.7	7.7	33.7	33.7	5.4	2.9	27.2			**Soft**

123 = concentration in mg/l, *123= concentration in Me/l* 123 = % Concentration in Meg/l.

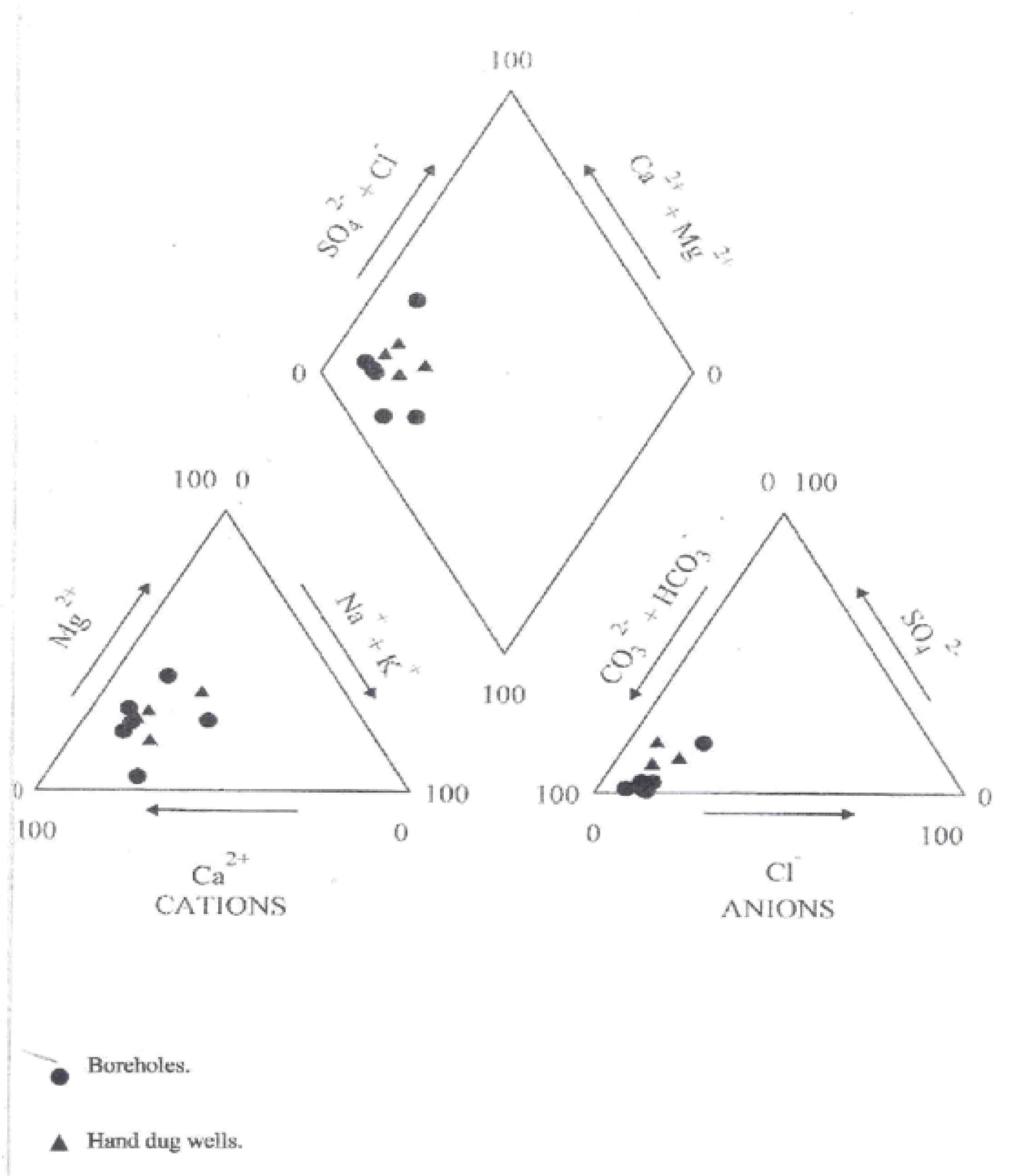

Fig. 11: Piper trilinear plot of water samples from the study area.

Fig 1: Piper Trinear Plot of Water Samples in the Study Area.

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ANIONS

Chlorine has an average value of 7.0mg/l in borehole wells and hand dug wells have an average value of 5.6mg/l and they fall within the standard limit of 2 – 25mg/l of W. H. O. (2009).

Nitrate has an average value of 12.2mg/l in bore whole wells and hand dug wells have an average value of 10.7mg/l and they fall within the standard limit of 1 – 25mg/l of W. H. O. (2009).

Sulphate has an average value of 2.5mg/l in borehole wells and hand dug wells have an average value of 6.0mg/l and they fall within the standard limit of 0.1 – 10mg/l of W. H. O. (2009).

Bicarbonate has an average value of 45m.2g/l in borehole wells and hand dug wells have an average value of 36.3mg/l and they fall within the standard limit of 20 – 120mg/l of W. H. O. (2009).

The chemical composition of groundwater is an important factor to be considered since groundwater is not chemically and biologically pure; this is to determine usefulness for domestic and agricultural use. The water samples analyzed have total mineralization as shown in table 1. This shows that the groundwater in the sturdy area can be said to be a Ca-Na-HC03 fresh to moderately hard water, (BH3, and BH5, BH1, BH2, BH4, BH6, HD1, HD2, HD3 and HD4) respectively. Generally since basement rocks contains minerals such as feldspars, amphiboles, micas and pyroxenes, which contain various amount of elements analyzed for, they are often released in the groundwater due to weathering of minerals. Water hardness is caused primarily by the presence o f cations such as calcium and magnesium and anions such as carbonate, bicarbonate, chloride and sulfate in water. It has no diverse effects; however some evidence indicates its role in heart disease (Kmumaresan 2006). The result is generally suitable, chemical quality for domestic and agricultural usage, the water is fresh to moderately hard. Hence the concentration of most of the undesirable element is commonly lower than the recommended limit for drinking water compared with W.H.O guide for potable water (2009).

The analyzed Na from table 1 shows concentration ranges between 0.02mg/l - 0.82mg/l with an average of 0.36mg/l in bore hole wells and 0.27mg/l in hand dug wells, while K concentration is within the range of 3.42mg/l -14.0mg/l with an average of 5.9mg/l in bore hole wells and 8.45 in hand dug wells (table1), the processes of weathering reaction series of plagioclase feldspars is the main source of Na in the groundwater. While the small percentage of K in the water despite its abundance in the earth crust have been attributed to its relative immobility and high resistance to weathering of many K minerals in relation to Na minerals (Davis and Dewies1996). The alkaline earth metals; Calcium is in the range of 112.0mg/l - 28.0mg/l and 1.3mh/l-19.1mg/l with averages of 15.5mg/l in the borehole wells, 22.3mg/l for the hand dug wells. Magnesium is in the range of 1.3mg/l – 19.1mg/l with averages of 10.6mg/l in the borehole wells, 11.8mg/l for the hand dug wells. In igneous and metamorphic rocks weathering releases Ca2+ from minerals such as Apatite, Amphiboles and Pyroxene groups. Also Magnesium can be obtained in solution by weathering of igneous and metamorphic rocks containing feldspars mica and pyroxene. For the chemical constituent analyzed they all fall within W.H.O. guide line (2009), therefore they are all permissible for drinking. However, in case of basement complex area generally, chloride concentration is low (Devis and Dewiest 1996).The possible source of chloride in the study area could be from the accumulation by evaportranspiration contributed into the groundwater system by precipitation. The concentration of chloride ranges from 3.7mg/l-11.3mh/l, the chlorite concentration falls within the
recommended limit of 25.0mg/l of W.H.O. (2009) level of 250mg/l for drinking water. The sulphate concentration in the analyzed sample is probably derived from oxidation of sulphate in the igneous rocks.

The sulphate concentration ranges from 0.20mg/l-9.20mg/l falls within the recommended limit of W.H.O. (2009) guide for drinking water. In case of nitrate it comes mostly from industrial, agricultural chemicals and fertilizer application. The most common source of nitrate concentration is attributed to animals and human waste disposal practices and the use of agricultural fertilizer. Here the nitrate ranges between 5.0mg/l-19.2mg/l is generally very low compared to 50mg/l of W.H.O. standard (2009). The iron concentration in the groundwater of the study area ranges from 0.06mg/l - 0.30mg/l also within the value of 3.omg/l of W.H.O. standard (2009).

Individual cation/anion analysis from Piper trillinear plot (fig 2) indicates moderate concentration of calcium/magnesium with a high concentration of bicarbonate but low concentration of chloride ion.

HT = Ca CaC03/Ca +Mg

CaC03/mg…………………………………………… ………………………………………………….. 1

Were HT , Ca2+ and Mg2+ are measured in mg/l and ratios in equivalent weights.

Equation 1 reduces to:

HT = 2.5Ca =4.1m………………………………………………… ……………………………………… 2

0-75…………………………………………………… ……………………………………………….. soft

76-150…………………………………………………… ………………………………..Moderately soft

151-300…………………………………………………… ………………………………………… Hard

>300………………………………………………… …………………………………………..Very Hard

CONCLUSION

The general assessment from table 2 classify the water in the study area as BH3 has (52.83) and BH5 has (69.19) as fresh water, while boreholes BH1 has (126.5), BH2 has (104.17) and BH6 has(90.20) and HD1 has (127.4), HD2 has (79.89), HD3 has (77.89) and HD4 has (907.41) as moderately hard is in agreement with the general assessment of the Piper trillinear plot (crystal shape) which also indicates low concentration of both calcium/magnesium and sulphate/chloride ions, they all fall within the recommended limit of W.H.O. (2009), the groundwater is good for drinking, domestic, industrial and agricultural purposes.

REFRENCES

1. Altman S.J , Parizek R.R., Dilution of nonpoint source nitrate in ground water, J. Environ. Quality, 1995, 24: 707-717.

2. Davis and Dawiest. Minerals associated with igneous rocks of the Northeastern Nigeria. (1996) Pp 60-65.

3. Kumaresan, M; Major ion chemistry of environmental samples around sub-urban of Chennai city, curr,Sci. 2006, Vol 91 No12.

4. Piper, A. M. A graphical procedure in geochemical interpretation of water analysis. Trans. America Geophysical Union 25 (1976) pp 914-915.

5. Rahman, M. A. Recent advances in study of basement complex of Nigeria. Pre Geol. Nig. Publication GSN. (1976). Pp 11-13

6. Sadashivaiah C, Ramamakrishnaiah, C. R. and Ranganna G. Hydrochemical Analysis and Evaluation of Groundwater quality in Tumkur Taluk, Karnataka State, India. Int J. Environs Res. Public Health (2008). Pp158-164.

7. Shittu O.B, Physicochemical and Bacteriological Analyses of Water Used for Drinking and Swimming Purposes in Abeokuta, Nigeria, African Journal of Biomedical Research, 2008, Vol. 11, 285-290. Swimming Purposes in Abeokuta, Nigeria, African Journal of Biomedical Research, 2008, Vol. 11, 285 -290.

8. Todd, D. K; Groundwater Hydrology. Wiley, New York, 1980; edn pp 315.

9. W. H. O. (2009) Guidelines for drinking water quality Vol1. Recommendations. World Health Organization, Geneva. Pp 130.