GROUNDWATER QUALITY IN ABAKALIKI AND ENVIRONS SOUTHEASTERN NIGERIA

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Abstract

Groundwater quality in Abakaliki and environs has been assessed. The water analysis has been earned out based on the physical, chemical and biological criteria of standard drinking water. The results obtained have been compared with the standards of various health organizations to determine its portability. One main problem associated with groundwater in Abakaliki area is hardness, which could probably be due to the effects of sandy limestone lenses and shale found within the Asu River Group. The coliform count is high in most places indicating that the human waste disposal system is poor within the study area.

***Keywords**:* Groundwater, Hardness, Coliform.

Introduction

The emphasis of this paper is on groundwater quality in shaly terrain of which the Abakaliki area is a good example. The paper is intended to highlight the significance of the quality of water we use, the problems that arise from the use of poor quality water and how much such problem can be curbed. Control measures include preventive and treatment measures. The groundwater quality has been discussed in relation to the geology and anthropogenic (human), activities of the state. The project area is dominated by urban dwellers that mainly use water for domestic purposes. The area lies between latitude $6^0$17'N and 6°22'N and longitude 8°05'E and 8"10'E. It covers such area as Ofe-iyiokwu, Ekaeru-inyimagu, Obiagu, etc (Fig 1). Sources of water to the inhabitants of the area are mainly public water supply, streams, bore holes and handy-dug wells. Irrespective of the fair distribution of water sources, provision of potable water remains an unsolved problem because of the nature of the geology and human activities.

Numerous researchers have carried out work on the aspects of hydrogeology and hydrogeoche-mistry of the southeastern part of Nigeria. They include Egboka (1983 & 1985), Uma and Egboka (1985), Ezeigbo (1988), Ofoma, et al (2005) and many others. Hence the aim of this study is to determine the portability of the groundwater in the area by comparing the chemistry with the WHO limits for drinking water.

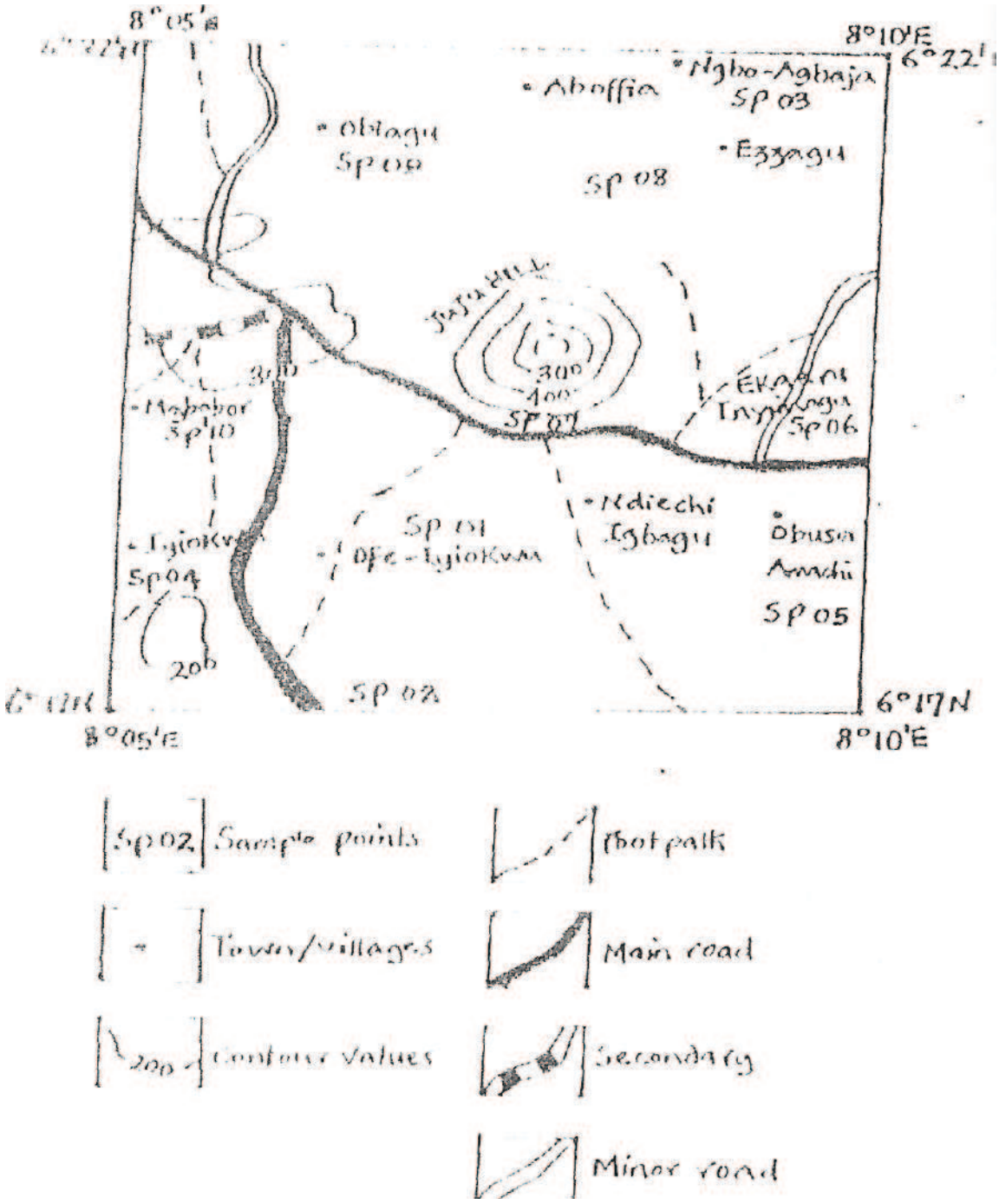

Fig 1: Sketch map of the study area showing accessibility and sampling points

Geology/Lithostratigraphy

The study area is located in the southeastern part of the lower Benue trough. The Benue trough is located at a major re-entrant in the African continent. It occupies an intra-continental position and has a thick compressionally folded cretaceous supracrustal fill (Murat, 1970; Catchley and Jones, 1975; Olade, 1975; Pellers, 1978. Numerous researchers ha\ c worked on the Geology of Southeastern Geology. They include Agunianu (1989), Nwachukwu (1972), Reyment (1963), Hoque (1984), Orajaka (1965), Offoegbu (1985), Nwajide (1979) and many others.

The study area lies within Asu River Group and consist mainly of rather poorly bedded shales, occasionally sandy, splintery meta-morphosed mudstones. Lenses of sandstone and sandy limestone are highly jointed and fractured. The Albion shale Formation in the study area are intruded by younger intrusives. The intrusive bodies in combination with numerous faults and joint systems have created fractures and secondary porosity in the study area. Topography of the study area is moderately Hat. Elevation ranges from 46m lo 7,'m above mean sea level. The study area is in the drainage area of Ebonyi River that flows on the southern side of (he study area. The approximate distribution of the Abakaliki shale occurs roughly over a radius of twenty-five kilometers. Palaeontologically. it is mainly characterize by species of moitonieeras and Hkibiceias, Radiolaria occur are echinoids may be locally abundant. Pelyypods and gastropods are relatively rare (Reyment. 1965). The sediments are folded and fractured particularly in the south of Abakaliki with the fold axes structuring in the NW-SE direction. The Formation is associated with the Lead-zinc mineralization.

Climate, Vegetation and Hydrogeologic Potential of the Study Area

The Abakaliki basin (Aptian - Sanlonian) is a subsidiary depresssion in the Benue trough of Nigeria. It is flanked on the southwest by the Afikpo syneline (late Campanian-Rocene). The Basin is characterized by a tropical climate with an average annual rainfall of 980mm. In the study area, two seasons are observed which are rainy and dry season. The months of rainy season air from March to October. The months of dry season are November to February. Most often this dry season period is occasioned by massive season water drought. The middle of Ibis period is characterized by harrnattan, which is experienced within the month of December and January. The area is within the tropical rain forest.

Groundwater development in the area is poor due to geological conditions, Hydrogeologically, ground- water development is not extensive; this is because the area is characterized by weathered and fractured zones which acts as aquifers. The thickness and the aerial extent of the weathered and fractured zone control groundwater storage.

Methodology

The methods employed for this study are Held investigation/ sampling and laboratory' analysis. A detailed field sampling exercise was earned out in February 2007, while laboratory analyses of the water sample were carried out within 12hours after sampling. The samples were collected in sterilized white plastic containers, PH was analyzed using a PH meters, while colour was measured against a standard solution in Nessier lubes. Cation were analysed using an atomic absorption spectrophoto-meter (Perkin-Hlemer AAS 3110), while anions were analyzed using the colorimetric method with the UV visible spectrophotometer WPAS 110. Total dissolved solids (TDS), were analyzed using the gravi-metric method. Analysis of coliform was carried out using the multiple tube/most probable number techniques (MPN). Aliquots of 100ml of each were used for the analysis.

Results

Ten (10) boreholes were sampled and analyzed for various physical-chemical parameters. Result shows that the concentration of colour **was** between 5 and 200 H**.** PH range between 6.6 nd 8.0; total hardness (T.H.), range between 360 and 7()0mg/l; and total dissolved solids (TDS), range between 80 and 450mg/l. For me cations (he values for Na~' range between 5.0 and I3.3mg/l, $\mathbf{k^{2'}}$ range between 0 and 6.3mg/l, I'e ' range between 0.2 and 3.4mg/l, Ca" range between 1.0 and 32.1 nig/I, Mg^{2}* range between 48.6 and I49.9mg/l and Hco_3 range from 58-369mg/l.

The conform bacteria fount range between 210 nml -2400MI'N / 100ml (table 1). The obtained results were compared with the WHO (1°84), highest desirable and maximum permissible limits, NAFDAC and standard organization of Nigeria (SON), limits fur drinking water to establish if the borehole water was tit for consumption (table 2, 3),

Table 1: Hydrochemical Data for the Study Area

No	Sample	PH	Colour (°H)	Na^+ Mg/l	K^+ Mg/L	Fe^{2+} Mg/l	TDS Mg/l	Ca^{2+} Mg/L	Mg^{2+} Mg/l	Pb^{2+} Mg/l	SO_4 Mg/l	NO_3 Mg/l	PO_4 Mg/L	Cl Mg/L	CO_3 Mg/L	HCO_3 Mg/l	Total Hardness Mg/L	BOD Mg/l	COD mg/l	Coliform MPN 100ml	Total solids
1	SP 1	8	15	116.8	3.8	0.6	350	12.00	68.1	0.03	8.6	0.2	0.1	3	0	358	480	8.65	328	524	36
2	SP 2	7.6	15	13.3	2.5	0.6	170	14	116.7	0.01	1.7	0.3	0.3	22	0	156	560	8.73	628	1100	18
3	SP 3	8	10	133.3	6.3	0.4	360	28.1	48.6	0.003	15.5	0.2	0.1	6	0	339	400	8.11	468	524	38
4	SP 4	7.7	20	83.3	0	0.9	450	30.5	149.9	0.003	1.7	0.6	0.4	239.9	0	194	640	9.32	328	1300	46
5	SP 5	8	10	133.3	0.9	1.1	380	30.5	97.3	0.01	9.5	0.9	0	4	0	369	500	3.18	384	1100	38
6	SP 6	7.4	5	5	2.8	1.7	80	28	145.9	0.01	6.9	1.1	0.1	13.00	0	58	360	3.38	464	>2400	9
7	SP 7	7.3	15	16.7	2.3	3.4	140	28.9	68.1	0.01	15.5	2.2	0.1	33	0	116	500	9.66	556	>2400	14
8	SP 8	6.6	10	15	1.7	0.2	240	24	136.2	0.01	6	3.9	0.2	55	0	192	600	8.11	640	>2400	25
9	SP 9	8	5	40	5.6	0.9	240	32.1	58.4	0.01	6	1.4	0.2	14	0	214	600	6.76	608	1100	24
10	SP 10	8	5	100	5.6	0.4	440	31.3	97.3	0.03	14.6	1.1	0.1	13	0	360	700	3.72	636	210	45

Table 2: Range values of physical-chemical parameters WHO (1984) standards for drinking water.

S/NO	Concentration level	Highest desirable level	Maximum permissible level
1	PH	7-8.5	6,5-9.2
2	Colour ("II)	5	50
3	Total dissolved solids (TDS) mg/l	500	1500
4	Total hardness (T.H) mg/l	100	500
5	Na^ Mg/l	NA	NA
6	K"$^+$ mg/l	NA	NA
7	CV* mg/l	75	200
8	Me""$^{l+}$" mg/l	50	150
9	Fe~*" mg/l	0.1	1.0
10	Po_4" mg/l	NA	NA
11	No_3 " mg/I	45	50
12	SO_4^{2-} Mg/l	200	400
13	cr	200	600
14	CO_3* Mg/l	NA	120
15	HCCV Mg/l	NA	NA
16	ColiformMPN/lOOml	0/1 00ml	0/1 00ml

Footnote: NA -Not available.

Table.3: NAFDAC and SON standards for drinking water.

S/No	Concentration level	NAFDAC	SON
1	PH	6.5-8.5	6.5-8.5
2	Colour (°H)	3	3
3	Total dissolved Solids (TDS)	500	500
4	Total Hardness (T.H) Mg/L	100	100
5	Na^{2+} Mg/L	NA	NA
6	K^{2+} Mg/L	10	10
7	Ca^{2+} Mg/L	75	75
8	Mg^{2+} Mg/L	20	20
9	Fe^{2+} Mg/L	0.3	0.3
10	PCV Mg/L	NA	NA
11	NCV Mg/L	10	10
12	SO_4^{2-} Mg/L	NA	NA
13	CP Mg/L	100	100
14	CO_3^{2-} Mg/L	NA	NA
15	HCO/ Mg/L	NA	NA
16	ColiformMPN/lOOml	0/lOOrnl	0/100ml

Footnote: NA - Not available

Table 4: Hardness classification of water (USEPA, 1976)

Hardness Mg/L $CaCO_3$	Water class
0-75	Soft
75-150	Moderately hard
150-300	Hard
>300	(Very

Discussion OF Result

The physical parameters measured-vi2 (colour) and PI I concentration falls within the WHO maximum permissible limits for drinking water, thus implying good water quality. The total dissolved solids (TDS), falls within the limits. Ca , $N0_3$, el" falls within the limit. Mg exceeds highest desirable but falls within maximum permissible level of WHO (1984). Total hardness (T.H.), Fe^{2+} and coliform count are excessively high > 2400MPN/100ml.

In most locations, the water tastes salty. The salty nature of the water is clue to the presence of hardness salts (calcium and magnesium) in the water. The water in some places possess slight In most locations, the water tastes salty. The salty nature of the water is due to the presence of hardness salts (calcium and magnesium) in the water. The water in some places possess slight metallic taste, this is due to the presence of iron and manganese. Colour imparted from soluble ferrous compounds may be removed through oxidation to insoluble ferric compounds and filtering out insoluble precipitate.

Faecal contamination of groundwater appears to be the most serious problem within the study area. The high col i form count indicates that human and animal waste disposal system within the area is poor. It is suspected that most of the wells are not properly cased and/or covered to shield them from direct ingress of bacteriological contaminated surface water or surface contaminants.

This infection occasionally causes deformity or incapacitation of the victims. The major diseases that arise from bacteriological contamination of water include typhoid, diarrhoea and cholera. Guinea worm (dracunculiasis) though serious is apparently restricted to few areas. The disease results in high infant mortality rate in the affected areas. Adults are also affected. Chlorination proves an effective treatment in case of proven bacteriological contami-nation and this should be effected through a series of tanks to ensure adequate contact time and hence effectiveness.

The total hardness (as CaCOs), of the water locations is extremely high. Hard water tends to originate in areas where thick topsoil overlies limestone or other calcareous rock Formations. The hardness could probably be due to the effects of the Ezeaku Formation and the Asu River Group that contains rich limestone units and sandy limestone lenses respectively including shale. Because of their adverse reaction with soap, hard water is unsatisfactory for cleansing purpose and some softening process are required for the removal of hardness (Hem, 1970).

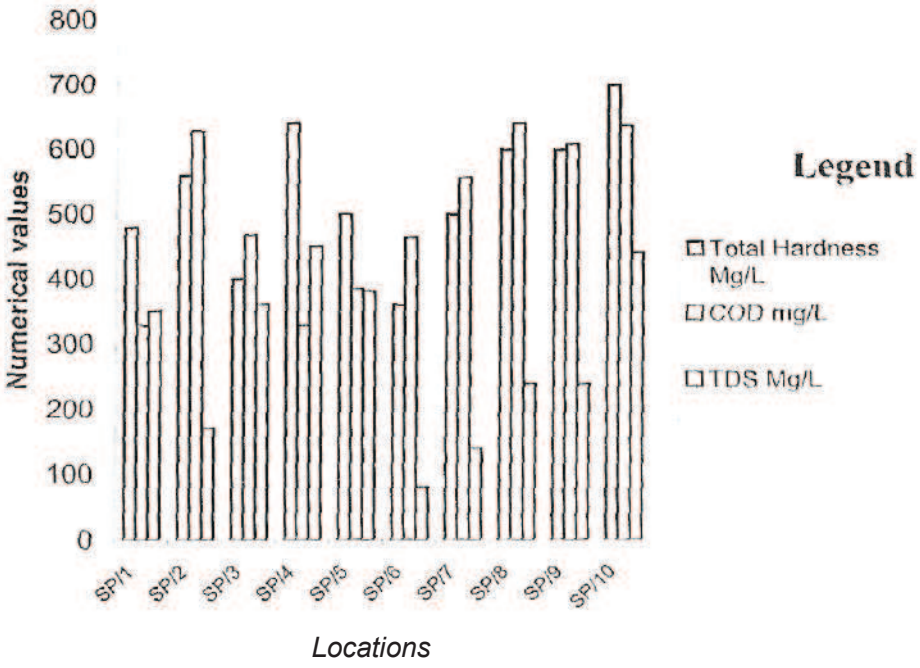

Fig 1: Bar chart showing the distribution of TOS, total hanlness anil COO in water sample within the study area

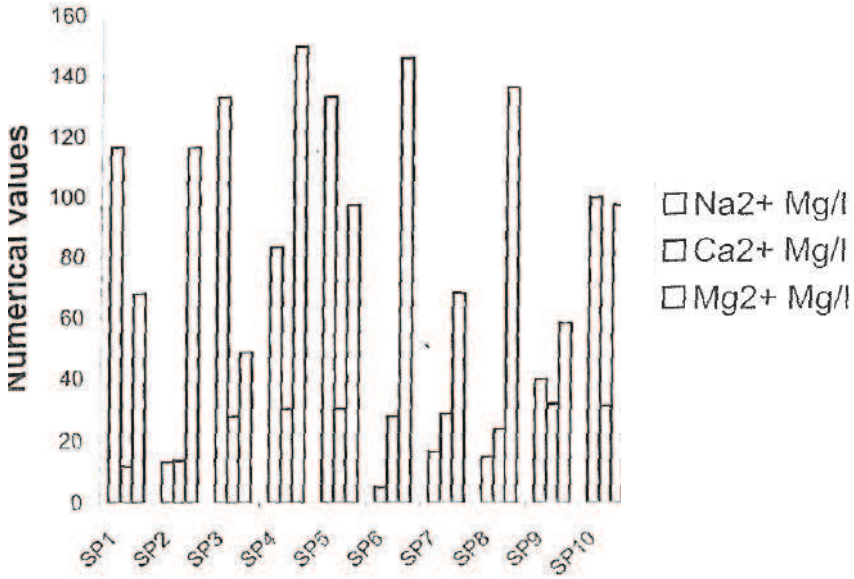

Fig 2: Bar chart showing the distribution of certain cations in the water sample within (he study

area

Summary and Conclusion

The quality of groundwater in Abakaliki is largely controlled by the Geology and hum" activities in the state. The Geology of the area consist mainly of the Albian Asu River Gro;.~ sediments dominantly shale with fine to medium grained consolidated Sandstone and Lime-stone :: places.

The colour, PH, $Ca^{"4}$, NO " and Cl falls within the limits of various standard organizations The

total hardness of the water exceeds the recommended limits. The coliform counts also exceed the limit. Faecal contamination of groundwater occurs in a number of areas due to the shallowness of indwells or due to the poor construction of the wells leading to the ingress of bacteriologies contaminated surface waters.

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