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Aspects of The Hydrogeology of Umuahia South Local Government Area, Abia State, Nigeria

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Some hydrogeological parameters of Umuahia South Local Government Area of Abia State, Nigeria, were studied to provide data for proper planning and execution of water projects in the area. Boreholes tap water from Miocene to Recent Benin Formation in the study area. This Formation is characterized by a multi-aquifer system in most places where it outcrops. Two aquifers were identified from lithologic logs in the study area within this Formation. These are the upper unconfined to confined aquifer between 30-60 meters depth, and an underlying confined aquifer between 80-160 meters depth. Static Water Levels are low and lie in the range of 28.3 -39.6 meters, while hydraulic heads vary from 80.3 to 127 meters. Hydrochemical studies show that groundwater in the area is low in dissolved constituents. However, iron requires treatment at some locations, while all the water samples should be treated for acidity. The hydrochemical facies identified include Na-K-HCO_3-Cl facies and Ca-Mg-HCO_3-Cl facies, with the former dominating. The ions in the water owe their source from geology and precipitation, while variation in the data can be explained by the exploitation of water from different aquiferous levels.

Keywords: Hydrogeology, Umuahia South, aquifers, hydrochemistry.

INTRODUCTION

There is a global recognition that groundwater quality is as important as its quantity. Current emphasis is not only on how abundant water is, but also on whether its quality status is good enough to sustain its various uses (Udom et al., (1999). The quality of groundwater determines its usability for domestic, industrial and agricultural purposes. The chemical composition of groundwater and the water types found in an environment are determined greatly by local geology, types of minerals found in the environment through which the recharge and groundwater flows, anthropogenic activities such as mining and waste disposal as well as climate and topography (Akpah and Ezeigbo, 2010). The quality status of water is a crucial factor in what the water is to be used for (Udom and Acra, 2006).For example, water meant for drinking and other domestic purposes must meet laid down local and international standards, otherwise the consumer stands the risk of water-borne diseases such as typhoid fever, dysentery, diarrhea and hepatitis.

The chemical constituents of groundwater is known to cause some health risks, so supply cannot be said to be safe if specific information on water quality which is needed for sustainable resource development and management is lacking (Nwankwoala and Udom, 2011).

Not much research work has been carried out on the hydrogeology of the study area, but few studies have been done on the quality status of groundwater in the area (Chukwu, 2008; Abii and Nwabienvanne, 2007; Amadi *et al*, 1989; Ngah and Allen, 2005).

Although the Imo River and its tributaries could provide sources of domestic water supply in Umuahia South Local Government Area, most people in the area prefer to use groundwater because of its

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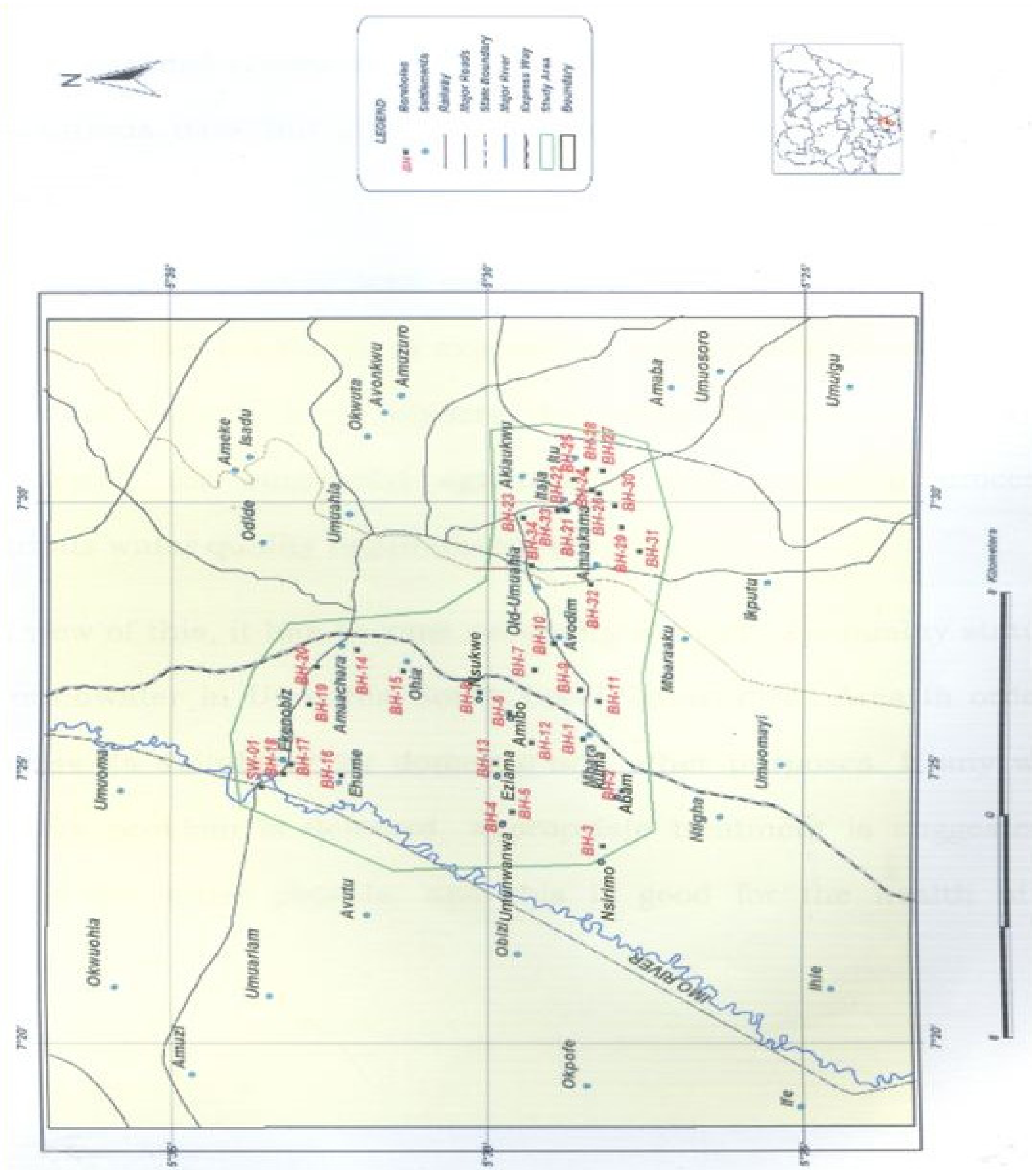

Figure 1: Map of study area showing sampled bore ole locations

advantages over surface water. It has therefore become necessary to study the groundwater potentials of the area for proper planning and execution of water projects. This paper attempts to highlight some of the hydrogeological parameters that could be useful in this direction. The results obtained would also add to the scanty hydrogeological information in the study area.

THE STUDY AREA

Umuahia South Local Government Area lies within the southeastern part of the Niger Delta Basin, between longitudes $7^0 22^I$ and $7^0 33^I$E and latitudes $5^0 26^1$and $5^0 34^I$ N (Figure.1). It is within the subequatorial climatic belt characterized by two major seasons; the wet and dry seasons. The wet season

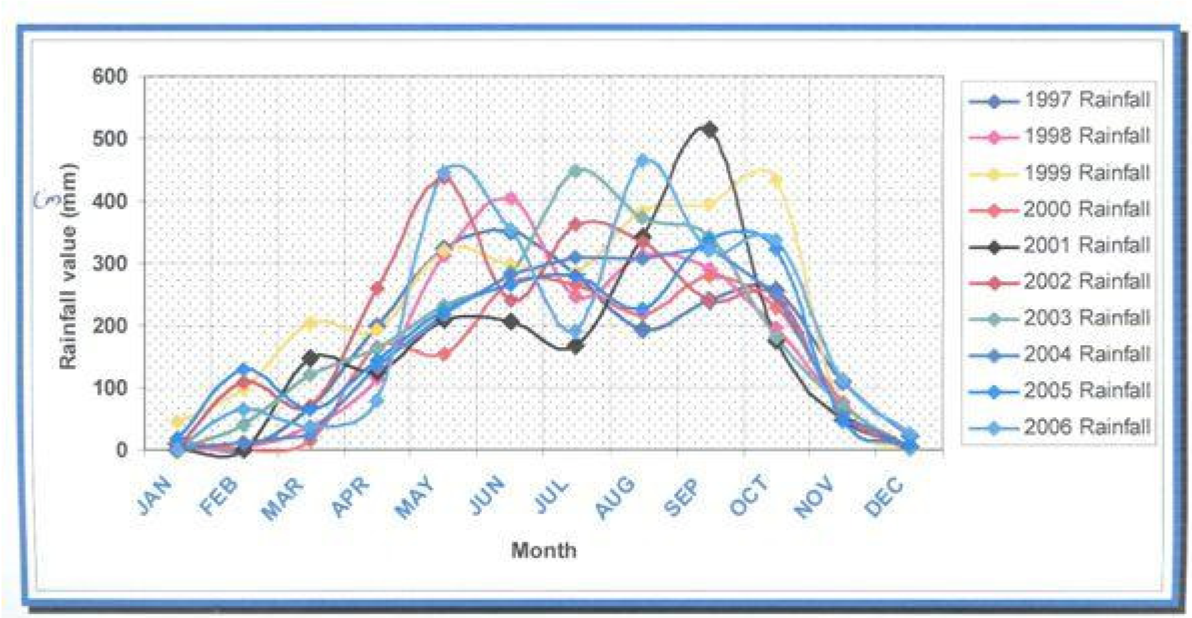

Figure. 2: Annual rainfall pattern in the study area.

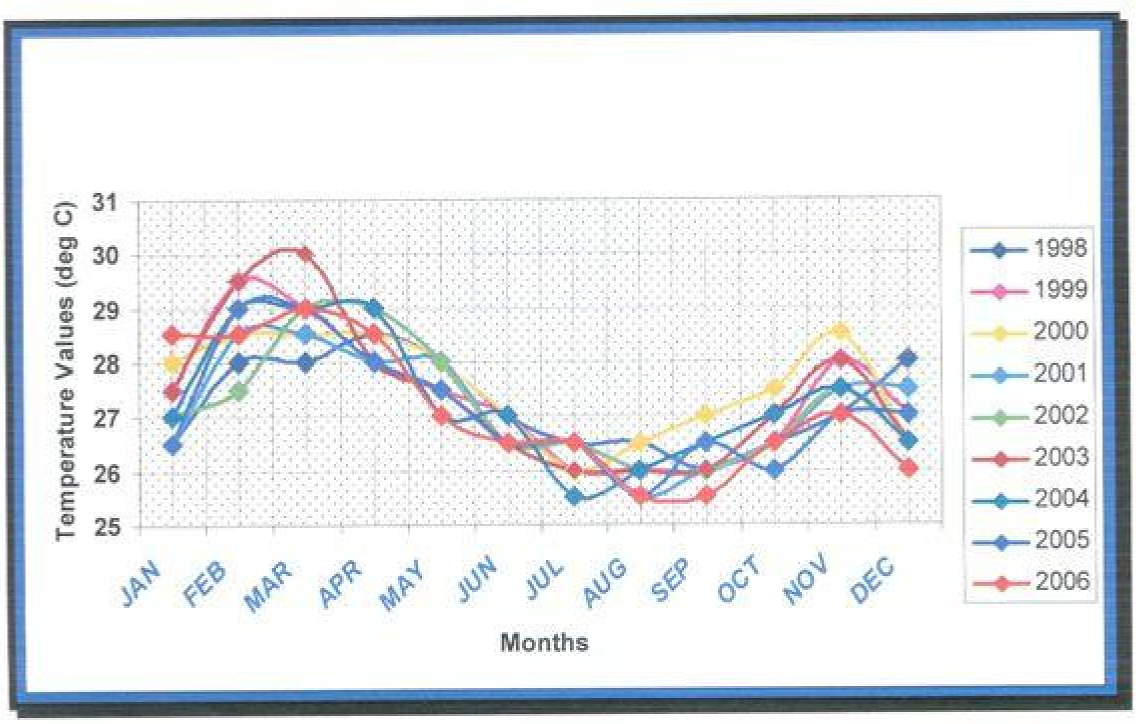

Figure. 3: Temperature pattern in the study area.

starts in April and ends in September with a peak in June and July, while the dry season lasts from October to March. However, recent global climatic change has affected the durations of these seasons. Rainfall is high in the area, with an annual average of about 400cm (Figure.2). Relative humidity is also high and generally are over 70%, while mean annual temperature is about 27^{0}C (Figure.3).

Relief and Drainage

Umuahia South Local Government area has low-lying to moderately high plain topography. The general surface elevation ranges between 59.5 and 164.5m above the sea level (Olobaniyi et al., 2006). The study area is drained by Imo River and its tributaries which flow in a southern direction and empties into the Atlantic Ocean. The drainage pattern is generally dendritic with tributaries generally in a southerly direction. According to Olabaniyi et al., (2006), the dendritic drainage nature of the area signifies a homogeneous underlying material where structural control is lacking. The draining river and its tributaries are perennial, resulting in dominant rainforest plants along their banks.

Geomorphology

The geomorphological setting has uniquely constrained the spatial spread of Umuahia area as a continuous landmass. The physiography of the area conforms to the geomorphic features of the Niger Delta, governed by several factors which influence transport, ultimate deposition of the sediment load, and shape and growth of the delta. It consists mainly of freshwater swamp, mangrove swamps, beaches, bars and estuaries (Etu-Efeotor and Odigi, 1983) which stretches from Benin River estuary for about 450km eastward and terminates at the mouth of the Imo River estuary, east of Port Harcourt City. It receives its sediments from the suspended and traction load of the Niger and Benue Rivers and their tributaries which in a total of about 21 estuaries, empties into the sea through the extensive plain along the coast.

The geomorphology of the area has attracted a considerable attention and has been discussed by various authors. Notable contributions of Allen, (1965a, 1965b); Short and Stauble, (1967); Akpokodje, (1989), and Weber, (1971) form the basis of the present knowledge.

Geology and Hydrogeology

The study area is located in the Eastern Niger Delta sedimentary basin. This basin was formed in the Tertiary period from the interplay between subsidence and deposition arising from a succession of transgressions and regressions of the sea (Hosper, 1965). This phenomenon gave rise to the deposition of three lithostratigraphic units in the Niger Delta. These units are Akata Formation, Agbada Formation, and the Benin Formation in order of decreasing age (Short and Stauble, 1965), (Figure.4). The overall thickness of these Tertiary sediments is about 10,000 meters. All boreholes in the study area tap water from the youngest, aquiferous Benin Formation. The Miocene to Recent Benin Formation is made up of sands which are mostly medium to coarse grained, pebbly, moderately sorted with local lenses of poorly cemented sands and clays. Based on petrographic analysis, Onyeagocha (1980) contends that the rocks are made up of about 95-99% quartz grains, Na+K-mica, 1-2.5%, feldspar 0-1.0%, and dark coloured minerals 2.3%.

The Akata and Agbada Formations are the source and reservoir rocks respectively for petroleum in the Niger Delta. Other details about the geology of the Niger Delta are given by Allen (1965b), Aseez (1976), Wright *et al* (1985), and Kogbe (1989). The sand-clay intercalations in the area are indicative of a multi-aquifer system. A Typical SP-Resistiviy log of a borehole in Umunwanwa (Figure.4) shows two aquiferous layers; the upper unconfined to confined aquifer between 30-60 meters; and a thicker confined aquifer between the depth of 80m and 160m. These aquifers are separated by clayey units whose thicknesses determine how thick the aquifer is in a particular borehole.

The high rainfall in the area provides enough recharge for the aquifers.

Materials and Methods

Borehole data and lithologic logs were obtained from the Anambra-Imo River Bssin Development Authority, Owerri for this study. Static Water Levels (SWL) and lithologic logs were used to delineate aquifers in the area. The hydraulic conductivity (K) values for the aquiferous layer between 67.1 and 88.3meters were studied in four boreholes by sieving the lithologic samples, plotting the data on semi-log papers, obtaining d10 values from the graph, and using same to calculate K from Hazens (1893) formula. The formula is given below:

K = Cd102

Where k = Hydraulic conductivity; C = constant; for K in cm/s and d10 in mm, c= 1 (Freeze and Cherry, 1979); D = 10 effective diameter, mm, defined as diameter such that 10 % by weight of the porous matrix consists of grains smaller than it.

Groundwater chemistry in the study was also studied. Water samples were collected from the boreholes shown in Figure.1 in clean 500 ml plastic bottles after pumping the wells for about five minutes to ensure stable conditions. After sample collection, the borehole lid was immediately replaced to minimize oxygen contamination and the escape of

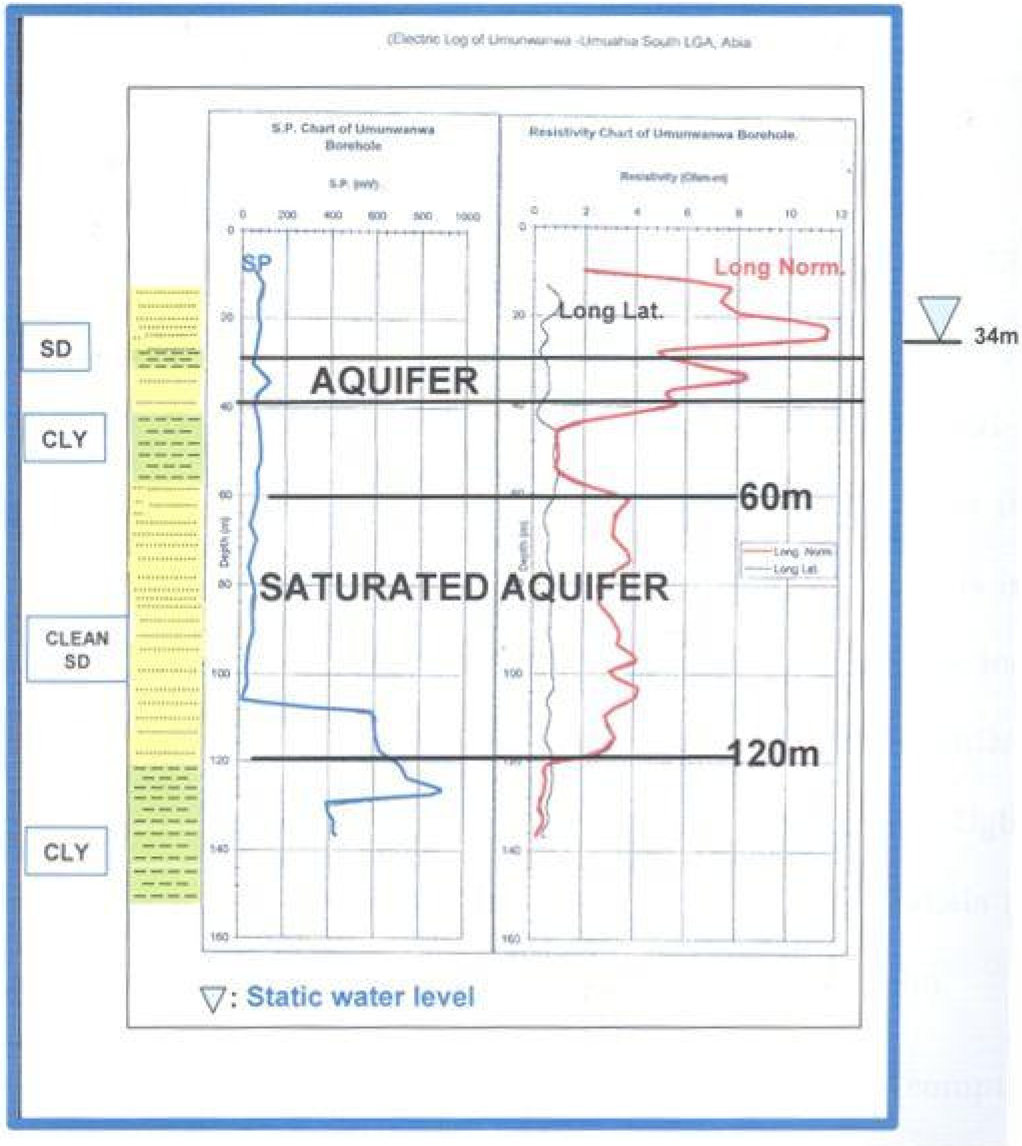

Figure. 4: SP-Resistivity log of Umunwanwa borehole (BH-5).
Source Data: Anambra-Imo River Basin Development Authority, Owerri.

dissolved gases. Analysis was done within 24 hours after sampling. However, temperature, electrical conductivity and pH were determined in the field due to their unstable nature. The analysis methods used are stated in Table 1.

Results and Discussion

Lithologic logs

The lithologic logs of six boreholes in the study area are shown in Figure.5. The logs show two major lithologies within the Benin Formation in the area studied. These include clay and sand deposits. The clay layers interbed the sands and give rise to a multi-aquifer system in the area. Multi-aquifer systems has been reported elsewhere in the Niger Delta by Etu-Efeotor (1981), Udom *et al* (1999, 2002), and others.

Aquifers

Generally in the study area, the first aquifer is encountered between 30 meters to 60 meters below the surface. It is unconfined to confined, depending on location. In BH34 and BH27 for example, the first

Table 1: Summary of Analytical Methods used for different parameters.

Parameter	Analysis method
Temperature	Thermometer
Conductivity	Conductivity Meter
pH	pH Meter
TDS	Filtration and Evaporation
TSS, Fe^{2+}, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, NO_3^{-}	Spectrophotometric
HCO_3^{-}, Cl^{-}	Titrimetric
SO_4^{2-}	Turbidimetric

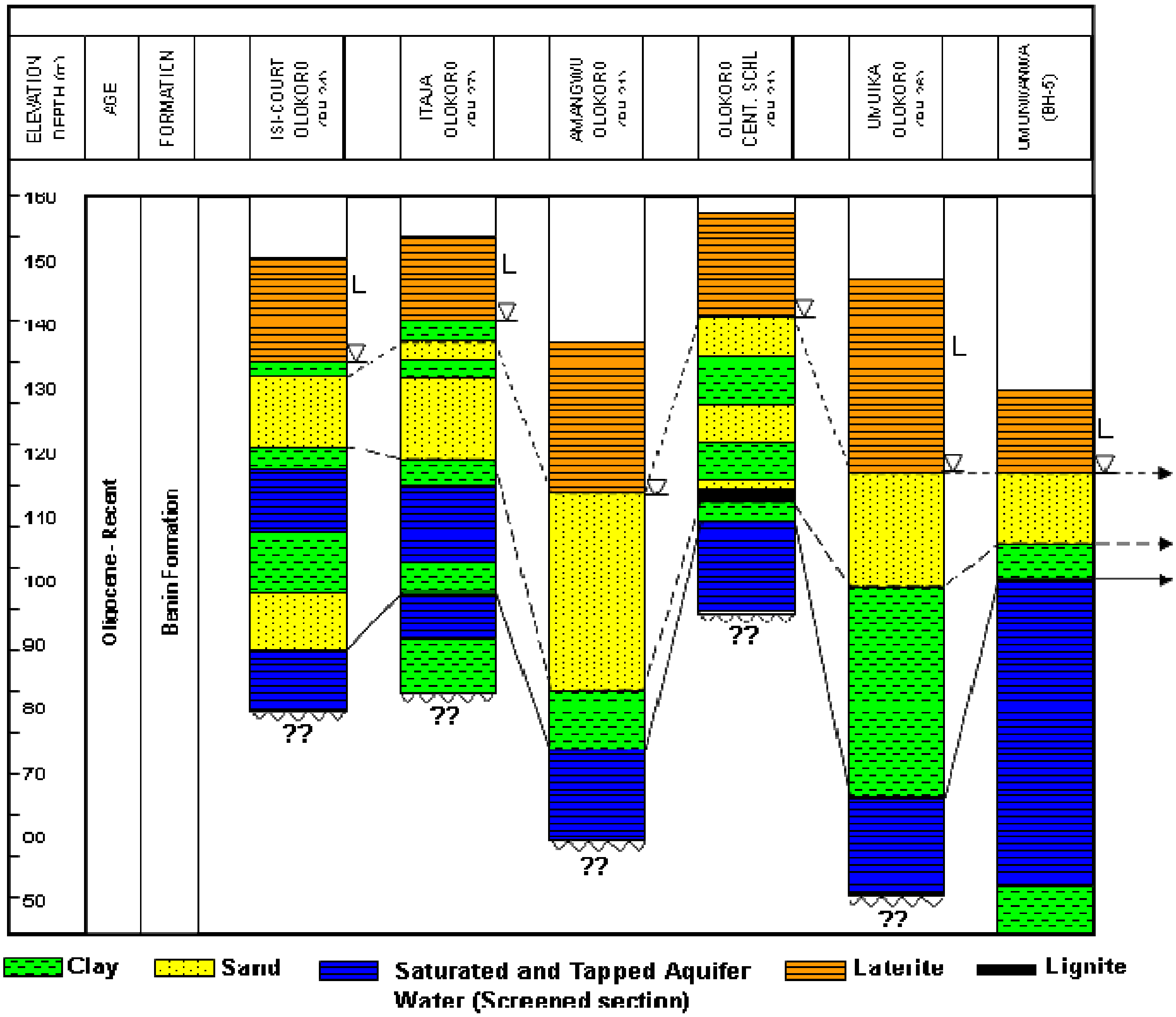

Figure 5: Lithologic logs of some boreholes in the study area.
Source: Anambra-Imo River Basin Development Authority, Owerri.

aquifer is confined by a clay horizon of about 20 meters thick on top and about 40 meters thick below , while in BH31, BH21, BH26, and BH5 it is unconfined (Figure.5). The unconfined aquifer In BH 31, BH 21, BH 26, and BH 5, varies in thickness as shown in Figure.5. The second aquifer commonly lies between

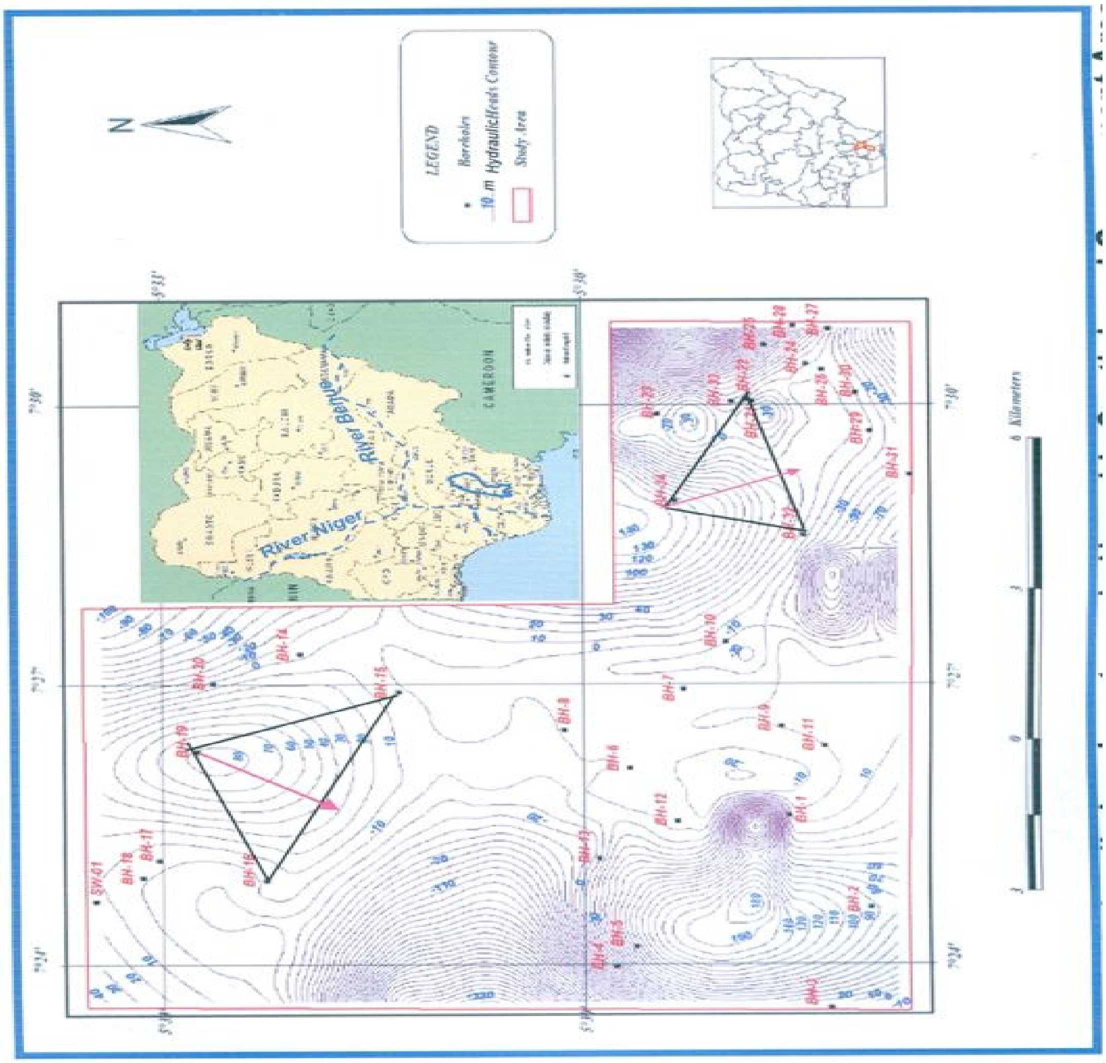

Figure 6: Hydraulic head contours in Umuahia South Local Government Area.

80 to 160 meters in depth in the study area. BH 5 in Umunwanwa has completely penetrated the second aquifer (Figure.5). This aquifer is about 40meters thick in this borehole. The other boreholes (BH 34, BH 27, BH 31, BH 21 and BH26) only penetrated this aquifer partially. This aquiferous layer is thicker than the first aquifer and all the boreholes studied tap water from it. However, the maximum depth penetrated by any of these boreholes was 160 meters in BH 5 in Umunwanwa.

Static Water Levels (SWL) / Hydraulic Heads

SWL and hydraulic heads vary from 28.3meters to 39.6meters and 80.3m to 127meters respectively in the study area (Table 2).

This shows low SWL in the area. With the low SWL's and clayey confining beds, the aquifers are protected from surface contaminants. However where the upper aquifer is unconfined, indiscriminate dumping of solid wastes on the ground surface should be avoided.

Figure.6 shows hydraulic head contours in the area, while Figure.7 is a 3-D representation of the hydraulic heads. From Figure 7, higher hydraulic heads are found in hilly areas, while the low heads characterize low lands.

Water Chemistry

Analytical results for physico-chemical parameters studied for some boreholes in the study area are

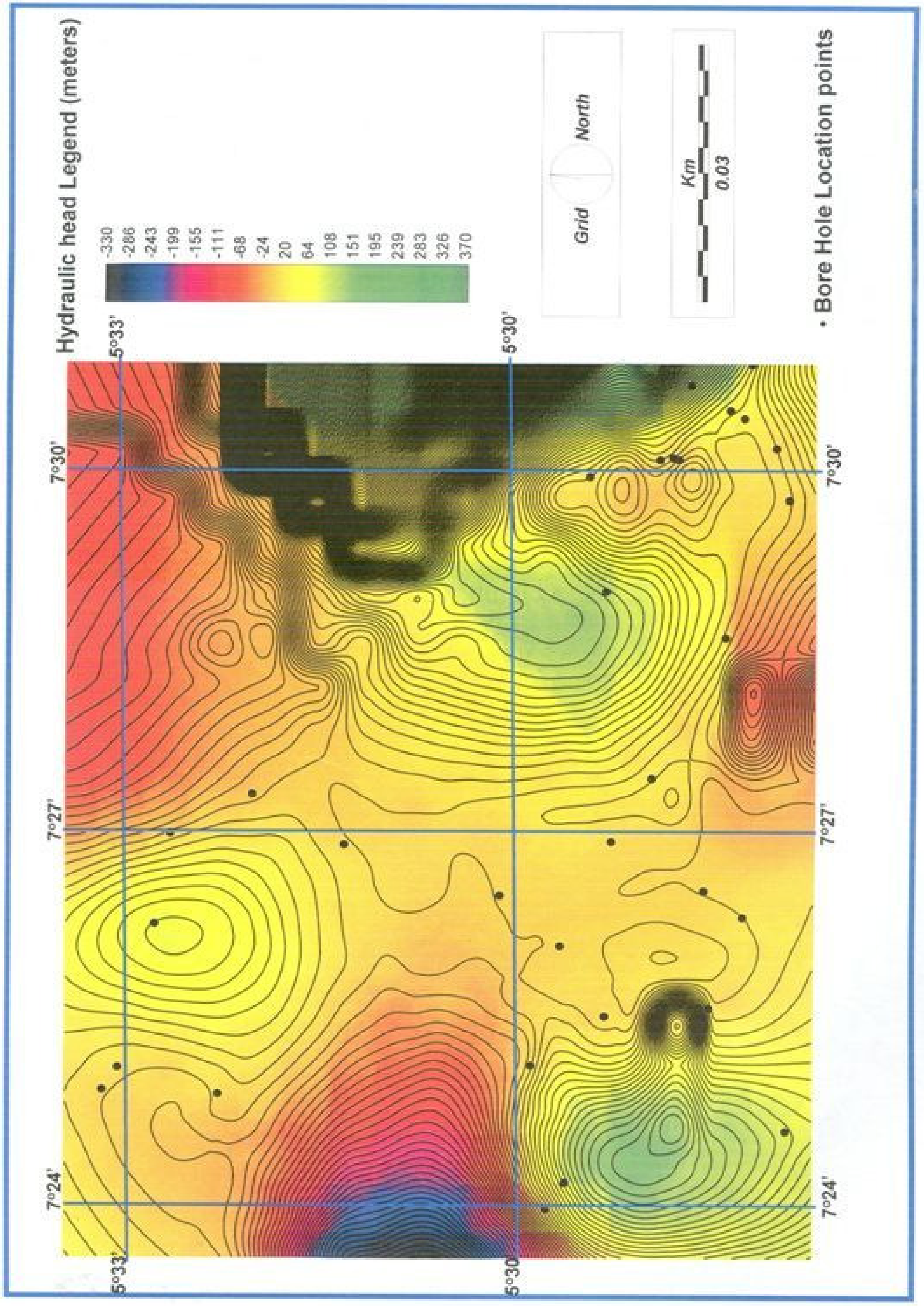

Figure 7: Digital elevation model for hydraulic heads in the study area.

stated in Table 3. The range in values of the parameters and the WHO (2004) standards are stated at the bottom of Table 3 for comparison.

Hydrogen ion activity (pH) values of the water samples lie between 4.39 and 6.65. This shows the presence of acidic groundwater in the area.

Table 2: Borehole Data in the study area

S/No	Borehole location	Coordinates		Borehole elevation (m.a.m.s.l)	Well Depth (m)	S.W.L (m)	Hydraulic Head (m)
		Northings	Eastings				
BH -1	Agbara Akuma	$05^{0}22.210^{1}$N	$07^{0}25.643^{1}$E	151.9			
BH -2	Abam	$05^{0}27.834^{1}$N	$07^{0}24.652^{1}$E	130.4		39.6	90.8
BH -3	Nsirimo	$05^{0}28.118^{1}$N	$07^{0}23.618^{1}$E	136.2		37.8	98.4
BH -4	Umunwanwa 1	$05^{0}29.726^{1}$N	$07^{0}24.058^{1}$E	116.9	98.0		
BH -5	Umunwanwa 2	$05^{0}29.565^{1}$N	$07^{0}24.269^{1}$E	119.7	137.0	34.2	85.5
BH -6	Amibo	$05^{0}29.592^{1}$N	$07^{0}26.168^{1}$E	118.4	91.0		
BH -7	Nsukwe-1	$05^{0}29.220^{1}$N	$07^{0}26.983^{1}$E	146.6			
BH -8	Nsukwe-2	$05^{0}30.079^{1}$N	$07^{0}26.563^{1}$E	125.2	91.4		
BH -9	Laguru	$05^{0}28.228^{1}$N	$07^{0}26.546^{1}$E	164.5	82.3		
BH -10	Avodim	$05^{0}28.052^{1}$N	$07^{0}27.600^{1}$E	133.3			
BH -11	Umuosh ivillage	$05^{0}28.183^{1}$N	$07^{0}26.413^{1}$E	161.5			
BH -12	Amuzu Ubakala	$05^{0}29.249^{1}$N	$07^{0}25.608^{1}$E	118.7			
BH -13	Eziema-Ubakala	$05^{0}29.859^{1}$N	$07^{0}25.198^{1}$E	108.8	91.4		
BH -14	Ogbidi-Ukwu Umuorinnoku	$05^{0}32.027^{1}$N	$07^{0}27.401^{1}$E	102.0			
BH -15	Ohia	$05^{0}31.304^{1}$N	$07^{0}26.938^{1}$E	103.5			
BH -16	Ehume Umuokpara	$05^{0}32.298^{1}$N	$07^{0}24.988^{1}$E	102.2			
BH -17	Ekenobizi Umuokpara (1)	$05^{0}33.117^{1}$N	$07^{0}25.162^{1}$E	96.1			
BH -18	Ekenobizi Umuokpara (2)	$05^{0}32.200^{1}$N	$07^{0}24.984^{1}$E	88.2			
BH -19	Ogbodi Ukwu-Umuakpara	$05^{0}32.791^{1}$N	$07^{0}26.333^{1}$E	110.0		29.7	80.3
BH -20	Amachara	$05^{0}28.660^{1}$N	$07^{0}27.056^{1}$E	130.5	73.1		
BH -21	Ahiaukwu, Olokoro-1	$05^{0}28.718^{1}$N	$07^{0}30.064^{1}$E	155.1	94.5		
BH -22	Ahiaukwu, Olokoro-2	$05^{0}29.827^{1}$N	$07^{0}30.060^{1}$E	142.2	61.0	29.3	112.9
BH -23	Umuobia Ahiaukwu Olokoro	$05^{0}28.379^{1}$N	$07^{0}29.922^{1}$E	155.5			
BH -24	Itaja Obuahia` Olokoro	$05^{0}28.384^{1}$N	$07^{0}30.844^{1}$E	143.9			
BH -25	Umuopara Ozara	$05^{0}28.600^{1}$N	$07^{0}30.619^{1}$E	155.3	98.0	28.3	127.0
BH -26	Umuika-Ukwu Olokoro	$05^{0}28.108^{1}$N	$07^{0}30.801^{1}$E	141.1	150.0		
BH -27	Itaja Olokoro-1	$05^{0}28.241^{1}$N	$07^{0}30.453^{1}$E	150.0	94.5		
BH -28	Itaja Olokoro-2	$05^{0}27.168^{1}$N	$07^{0}30.376^{1}$E	159.2			
BH -29	Amizi Olokoro	$05^{0}27.936^{1}$N	$07^{0}30.100^{1}$E	146.3			
BH -30	Umuajata Olokoro	$05^{0}27.802^{1}$N	$07^{0}29.722^{1}$E	140.1			
BH -31	Amangwu Elulu	$05^{0}28.556^{1}$N	$07^{0}29.279^{1}$E	124.0	119.0		
BH -32	Amakama-Olokoro	$05^{0}28.313^{1}$N	$07^{0}28.634^{1}$E	146.2			
BH -33	Ahiaukwu-Olokoro	$05^{0}29.698^{1}$N	$07^{0}30.111^{1}$E	152.6		35.09	117.51
BH-34	Isi-Olokoro	$05^{0}29.238^{1}$N	$07^{0}28.997^{1}$E	146.6	100.6		

The boreholes from where these water samples were collected tap water from the second aquifer in the area.

The mean temperature and electrical conductivity values in the area are 29.4^{o}C and 30.2µs/cm respectively. The temperature of groundwater in the area is reflective of physiogeographic conditions, while conductivity values show absence of salt water in the area, and have direct relationship with Total Dissolved Solids (TDS). TDS values are also low (2.38mg/l – 50.7mg/l), and below WHO (2004) standard of 1000mg/l. TDS above 1000mg/l shows salt water.

The cations studied include iron (Fe^{2+}), calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}), and potassium (K^{+}). Na^{+} and K^{+} dominate the other

Table 3: Results of Physico-Chemical Composition of Groundwater samples in the study area

Borehole S/No	Borehole Locations	Temp (°C)	Cond. (μs/cm)	pH	TDS (mg/l)	TSS (mg/l)	Fe^{2+} (mg/l)	Ca^{2+} (mg/l)	Mg^{2+} (mg/l)	Na^{2+} (mg/l)	K^{+} (mg/l)	HCO_3^- (mg/l)	Cl^- (mg/l)	SO_4^{2-} (mg/l)	NO_3^- (mg/l)
BH-1	Agbara Akuma	29.5	23.4	5.54	11.70	BDL	0.01	0.48	0.07	2.14	0.16	45.00	4.69	BDL	
BH-2	Abam	29.0	27.3	5.07	13.60	BDL	0.02	0.44	0.07	2.12	0.11	30.50	4.96	BDL	BDL
BH-3	Nsirimo	28.0	14.7	5.07	7.30	BDL	0.01	0.43	0.06	2.14	0.09	30.50	5.32	BDL	BDL
BH-4	Umunwanwa	30.0	41.5	4.47	20.60	BDL	0.01	0.42	0.06	2.17	0.09	30.50	5.32	BDL	BDL
BH-6	Amibo	31.0	23.8	4.47	11.90	BDL	0.02	0.57	0.11	3.14	0.18	45.75	4.96	BDL	BDL
BH-7	Nsukwe-1	31.0	21.1	4.52	10.80	BDL	0.01	0.54	0.09	3.14	0.16	45.75	5.67	BDL	BDL
BH-8	Nsukwu-2	30.0	19.0	5.40	9.50	1.0	0.11	0.34	0.07	2.26	0.12	30.50	5.67	BDL	BDL
BH-9	Laguru	31.0	14.1	4.94	7.00	1.0	0.02	0.42	0.06	2.11	0.13	30.50	5.52	BDL	BDL
BH-10	Avodim	30.0	20.2	4.80	10.10	BDL	0.02	0.53	0.11	2.11	0.16	30.50	5.67	BDL	BDL
BH-11	Umuoshi	28.0	23.7	4.73	11.80	1.0	0.11	0.55	0.12	1.92	0.16	30.50	4.60	BDL	BDL
BH-12	Amuzu Ubakala	28.0	20.7	4.64	10.30	1.0	0.09	0.53	0.12	2.72	0.14	30.50	6.05	BDL	BDL
BH-13	Eziama Ubakala	28.5	21.9	4.63	10.90	BDL	0.03	0.49	0.11	2.08	0.13	30.50	5.67	BDL	BDL
BH-14	Ogbodi Ukwu	29.0	35.6	5.28	17.70	BDL	0.04	0.77	0.21	3.04	0.21	45.75	5.67	BDL	BDL
BH-15	Ohia	29.5	46.8	4.39	23.40	1.0	0.10	1.07	0.26	3.05	0.91	30.50	5.32	BDL	BDL
BH-16	Ehume Umuokpara	29.0	37.4	4.25	18.50	2.0	0.13	0.65	0.11	2.81	0.20	30.50	5.67	BDL	BDL
BH-17	Ekenobizi Umuokpara-1	29.0	21.6	4.79	10.80	BDL	0.02	0.52	0.08	2.12	0.17	30.50	5.67	BDL	BDL
BH-18	Ekenobizi Umuokpara-2	29.0	20.5	4.85	10.20	1.0	0.02	0.38	0.05	2.11	0.13	30.50	5.67	BDL	BDL
BH-19	Ogbodi Ukwu Umuokpara	30.0	32.2	4.65	16.10	7.0	0.73	0.62	0.15	3.12	0.20	30.50	4.96	BDL	BDL
BH-20	Amachara	28.0	20.8	4.56	10.40	BDL	0.06	0.48	0.07	2.02	0.16	30.50	6.03	BDL	BDL
BH-22	Ahiaukwu Olokoro	30.0	31.4	4.94	15.70	BDL	0.01	0.42	0.06	2.34	0.12	30.50	5.67	BDL	BDL
BH-23	Umuobia Ahiaukwu	31.0	14.9	4.84	7.40	1.0	0.02	0.53	0.09	2.43	0.15	30.50	5.32	BDL	BDL
BH-24	Itaja-Obuohia Olokoro	30.0	32.9	4.77	16.40	1.0	0.02	0.52	0.08	3.02	0.14	30.50	5.32	BDL	BDL
BH-25	Umuika-Ukwu Olokoro	28.5	-	6.45	2.38	25.48	0.11	7.75	1.42	3.57	2.55	-	0.01	BDL	BDL
BH-26	Itaja Olokoro Umuokpayi	30.0	42.2	5.07	21.10	3.0	0.41	1.68	0.63	3.06	0.61	45.00	5.32	BDL	BDL
BH-27	Amizi	29.5	101.5	4.44	50.70	1.0	0.41	5.12	1.06	5.54	1.79	30.50	10.64	BDL	BDL
BH-28	Umuajata-Olokoro	28.0	52.9	4.64	26.40	8.0	0.24	1.22	0.37	2.79	0.41	30.50	8.86	BDL	BDL
BH-29	Amakama- Olokoro	30.0	22.0	5.10	10.90	4.0	BDL	0.78	0.13	3.14	0.23	45.00	4.96	BDL	BDL

Table 3: Cont.

Maximum	31	101.5	6.56	50.7	25.84	2.78	7.75	1.42	5.54	2.55	45.7	8.86	BDL	BDL
Minimum	28.0	14.1	4.39	2.38	BDL	0.01	0.42	0.06	1.92	0.12	30.5	0.01	BDL	BDL
Range	28-31	14.1-101.5	4.39-6.56	2.38-50.7	BDL-25.84	0.01-2.78	0.42-7.75	0.06-1.42	1.92-5.54	0.12-2.55	30.5-45.7	0.01-10.64		
UK(1998)Standard	25	1500	5.5-9.5	50-750 1000	NS	0.2	250	50	150	12	30	400	250	250
WHO(2004)Standard	NS	NS	6.5-8.5		NS	0.3	NS	NS	200	NS	NS	250	250	50
Average	29.4	30.2	4.87	14.58		0.10	1.05	0.22	2.67	0.36	32.68	5.54		

cations. The average concentrations of these ions are Fe^{2+}, 1.10mg/l; Ca^{2+}, 1.05mg/l; Mg^{+}, 0.22mg/l; Na^{+}, 2.67mg/l; and K^{+}, 0.36mg/l. The levels of all these ions are low and within (WHO, 2004) stipulated standards. However, the levels of Fe^{2+} in BH 24, BH25, and BH26 (Table 3) are slightly higher than the standard of 0.3mg/l by (WHO, 2004).

The boreholes in the area tap water from the Benin Formation which is characterized by clay intercalations. Na^{+} and Ca^{+} are exchangeable bases in some of the clay minerals, while the feldspars in this Formation also partly account for the presence of these ions as well as K^{+} in the water. Iron is abundant in iron minerals like hematite and goethite in the Benin Formation. This explains the source of iron in the water.

Bicarbonate (HCO_3^-), chloride (Cl^-), and sulphate (SO_4^{2-}), anions were also studied. The concentrations of these ions are low; $SO4^{2-}$ was not detected in any of the samples by the equipment used. HCO_3^- dominates these anions and range in concentration from 30.5mg/l to 45.7mg/l. The activities of biota in the soil and CO_2 in the atmosphere account for the presence of this ion in the water. Chloride values range from 0.01mg/l in Umuika-Okwu Olokoro to 10.64mg/l in Amizi. Its average concentration in the water is 5.54mg/l. This level of chloride is low when compared to the stipulated value of 250mg/l for potable water by WHO (2004). The low chloride levels are also indicative of the absence of salt water intrusion into the exploited aquifer. According to Tremblay et al., (1973), chloride content up to 40mg/l in water indicates salt water contamination. Chloride moves through aquifers at nearly the same rate as the intruding water (Hem, 1985), and where no other source of saline contamination exists, high chloride concentrations in groundwater can be considered rather definite proof of saltwater contamination. The low chloride found in the water probably owes its source from precipitation, which is the major source of recharge for the aquifers.

Hydrogeochemical Facies

The concept of hydrogeochemical facies has been used (Back, 1966; Morgan and Winner, 1962) to denote the diagnostic chemical character of water solutions in hydrologic systems. The facies reflect the effect of chemical processes occurring between the minerals of the lithologic framework and groundwater (Edet, 1993). The subsequent flow patterns modify the facies and control their distribution. Piper (1944) Trilinear diagram was used to classify groundwater types in the area. It permits the cation and anion compositions of many samples to be presented on a single graph in which major groupings or trends in the data can be discerned visually (Freeze and Cherry, 1979). Piper trilinear diagram shows that two hydro

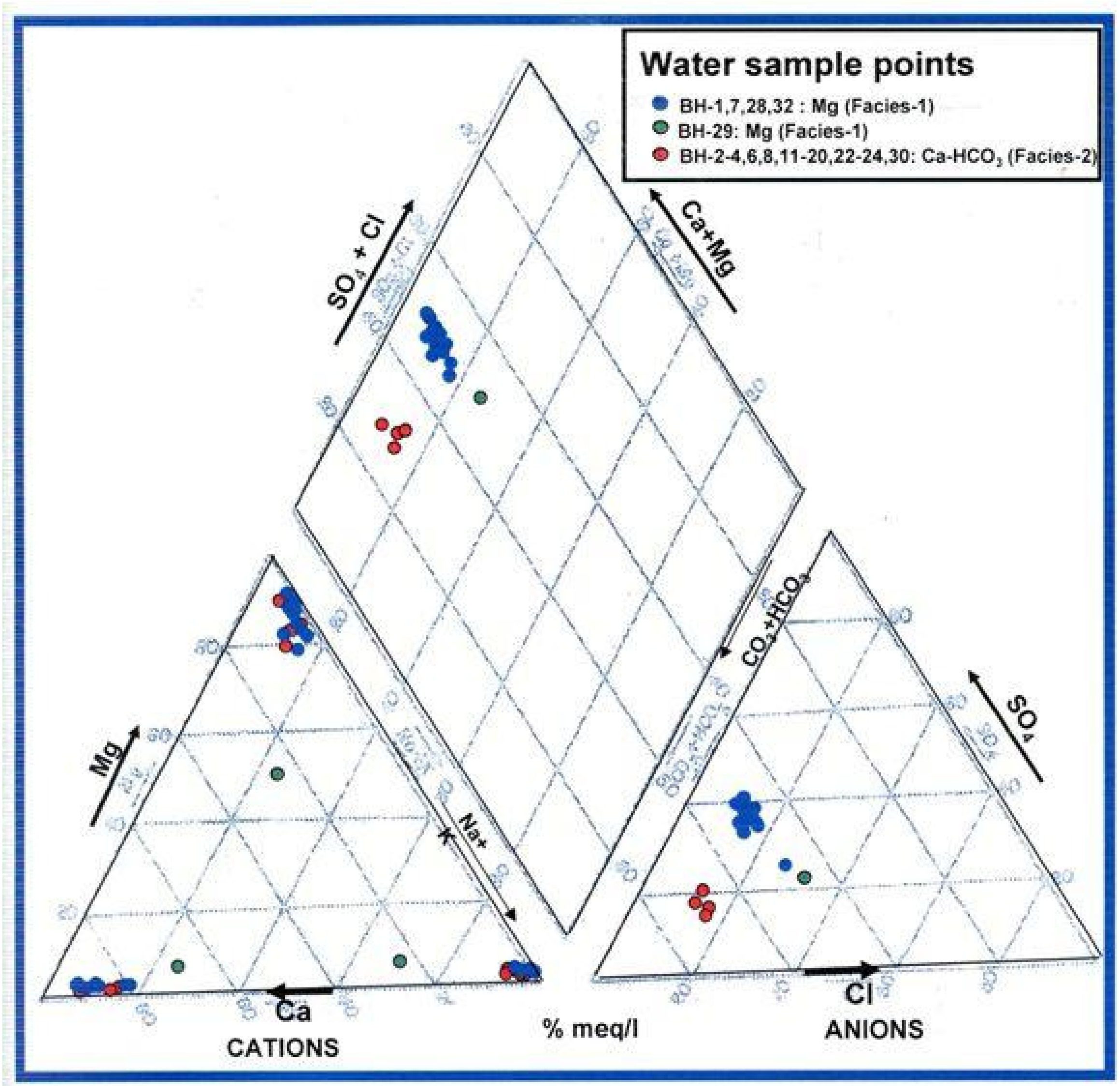

Figure 8: Trilinear diagram plot of the water samples in the study area.

chemical facies occur in the study area (Figure 8). These include Na+K-HC

CONCLUSIONS

Boreholes in Umuahia South Local Government Area tap water from the Miocene to Recent Benin Formation. A multi-aquifer system exists within this Formation. Two aquifers were identified from lithologic logs of boreholes; the upper unconfined to confined aquifer, and the second aquifer which is confined. Borehole drillers should target the first aquifer between 30-60 metre depth, and the second aquifer between 80-60 metre depths. However, this recommendation does not supersede geophysical studies prior to drilling and the need to have a geologist at the site during drilling.

Static water levels are low in the area and commonly lie between 28.3meters and 39.6 metres; while hydraulic heads vary from 80.3metres to 127 metres.

Groundwater in the area is low in dissolved constituents. However, iron requires treatment at some locations. Aeration and filtration is enough to get rid of the iron. PH values show acidic groundwater. Because of this, PVC materials should be used for borehole construction in the area. Also the water should be treated for acidity. This could be done by allowing it to pass through granules of dolomite. During the process, hardness is increased but not in an amount that could cause any serious worries.

Two hydrochemical facies have been identified. These are: Na+ K-HCO_3-Cl Facies and Ca+Mg-HCO_3-Cl Facie, with the former dominating.

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