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HYDROGEOLOGICAL ANALYSIS OF LITHOGRAPHIC UNITS OF NORTHERN KATSINA STATE, NIGERIA

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ABSTRACT

In this present study, the hydrogeological (conditions) analysis of lithographic units of Northern Katsina State, Nigeria which comprises the thirteen (13) Local Government Areas was carried out. The research excludes sampling and laboratory experiment of water samples within the study areas, but a regional survey of water-bearing mediums and their physical characters. It therefore thought to review the previous drilling survey carried out by NGO's in the past periods. The methodology adopted for the study was mainly secondary data. In the major findings in the areas, almost 85% of the total areas covered are underlain by rocks of the Basement Complex (BC) which have lesser yield, the remaining 15% are covered by Illo-Gundumi formation (Cretaceous) which is expected to have high yield and the Chad Basin formation with a very potential yield and which is also the youngest formation (Tertiary-Quaternary) It is recommended that hydrogeological investigations be done regularly to get up-to-date data for human and ecosystem development.

Keywords: *Hydrogeology, Lithographic Units, Environmental Pollution, Northern Katsina State*

INTRODUCTION

The Geophysical survey in North Katsina State during the Groundwater exploration and exploitation in the yester years were Wenner's Array method that exploited Aquifers within the region laterally and which also determine its Resistivity Profile (RP), and the Schlumberger Array method that exploited the Aquifers vertically, which also determine the Vertical Electrical Sounding (VES)

The geology of the area Katsina Region is strictly speaking divided into Basement Complex (Older granites, migmatites, metasediments which are schist and phyllites, granite gneiss) which occupy about 90% of the region, the Cretaceous Gundumi formations at the extreme northern part (ferruginous sand stones, siliceous sand stones, grits, arkose, basal conglomerates, breccia, oolitic sand stones with a lot of iron in them) comprising of 8% and the Chad formation (Tertiary-Quaternary) at the extreme north east (ultimate sand clay) which comprises of only 2% of the total area coverage which is also the youngest (Bajarski, 1971; Kankara, 2017) Katsina State has very little surface drainage-rivers and lakes. Even, many of those present are either intermittent or reduce drastically in volume (during the prolonged dry season)

It however appears to be a hydrographically active region because the water resources and most rivers take their sources from the basement complex plains and pediments in the center of the State and flows out of the State.

For example, the Gada and Bunsuru rivers take source from these plains and flow into Zamfara State to becomes tributaries to the Rima River. The Sokoto River also takes its source from this same region before flowing out. Other identifiable rivers and water bodies in the area that flow all year are Rivers Gada, Tagwai, Yeska, Karaduwa, Sabke, Ajiwa, Zobe, Koza and many smaller streams.

Most areas are underlain by crystalline rocks over the basement complex rock, groundwater is thus unpredictable. The crystalline rocks are impervious. However, fracturing, fissuring, jointing and weathering may impose secondary aquifer characteristics on these rocks, (Danbatta, 1999) thus making them favorable to ground water storage. Ground water in this zone is unconfined.

Water table is restricted to sub-basins, which may be locally and hydrologically isolated. Borehole yield vary widely, average safe yield of successful ones being of the order of only a few hundred liters per hour. Maximum yield of 2000 gph (gallons per hour) with a drawdown of 26.3rn was recorded in Daura area (Mckenzie, 1985; Kankara, 2017)

Groundwater is mostly tapped by hand-dug wells for agricultural and domestic purposes. In some cases, groundwater has been drawn upon to augment supplies from surface sources. The Gundumi formation in the extreme northern part of the State also yields was under artesian pressure. Where the formations are confined by younger formation with depths varying from 300m-610m, free flow yield of 500 gph to 1500 gph has been recorded (Kankara, 2017)

STUDY AREA

Northern Katsina State covers Latitudes 11° 18'N and 13° 22' N, (see Figure 1) and Longitudes 6° 52'E and 9° 20'E. It was built on a spur of land between Ginzo and Tilla streams which flows in a north-easterly direction around Katsina metropolis, and many more as discussed above.

The climate is Tropical Continental type, classified according to Koppen's Climate Classification as AW, with long dry season and short wet season (Babsal, 1998). It is a limiting factor to water resources, especially underground water reserves as it has not exceeded 550mm of water obtained per annum. Thickness of the dry zone in the areas depend on the climate. This therefore shed emphasis on the geology of the area as a limiting factor too.

Vegetation type is Sudan Savannah with short scattered trees and grasses. Most of the vegetation is affected by human activities such as deforestation for fuel wood and clearance of vegetation for residential purpose (Kankara, 2017) Katsina State falls entirely into the Sudan/Sahel grasslands of Northern Nigeria. The undeveloped shortish flora of this area bears eloquent testimony of the low rainfall characteristics of this area. Generally, three different vegetation formation zones are identifiable over the State; they are grassland, shrub land/grassland and woodlands. The Grassland is found around the northernmost parts of the State over the Gundumi formations, it consists of very short grasses and shrub with very thick bark. Grasses found in this area include *Andropogan* spp, Aristde, *Pennisetum* Pedicellatum. Shrubs include Acacia spp, *Balanites* aegyptia,ca, *Boscia* Senegalensis, etc.

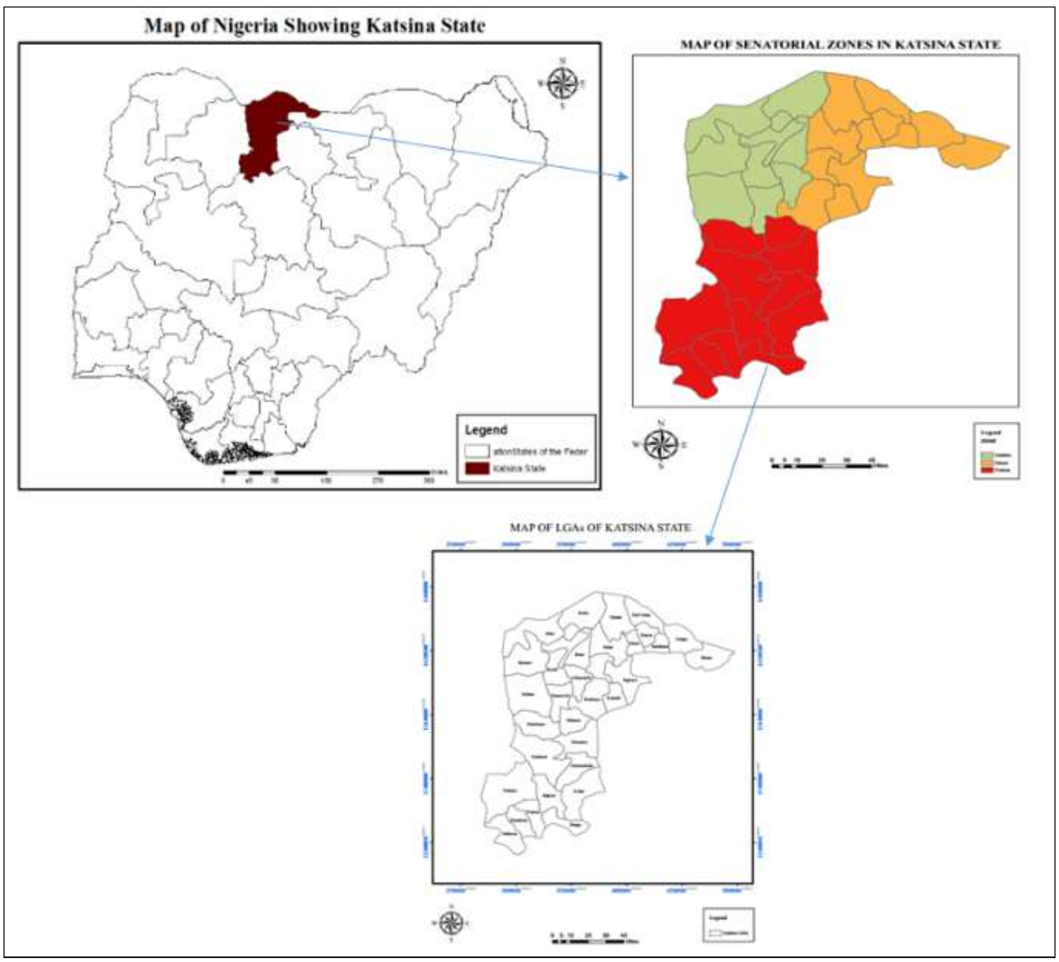

Fig. 1: Map of Katsina State showing northern Katsina in yellow and green colours, showing their Geological Distributions.

GEOLOGY OF THE STUDY AREA

The geology of the area governs the nature of river flowage. The project area lies within the Nigerian Basement Complex which is divided into crystalline basement of migmatite and gneisses. The crystalline basement initially behaved as one tectonic unit, but later experienced two periods of syn-tectonic metamorphisms with deformations in two successive phases called the Intense Alpine type's deformations. The deformations took place during the Pan African Orogeny (McCurry & Wright, 1971; Kent 1981) which were accompanied by metamorphism, granitization and feldspatization. The first tectonics resulted in extensive migmatization of the basement but was further differentiated during the second tectonics to produce homogenous gneiss and intrusive granites (Kogbe , 1976a)

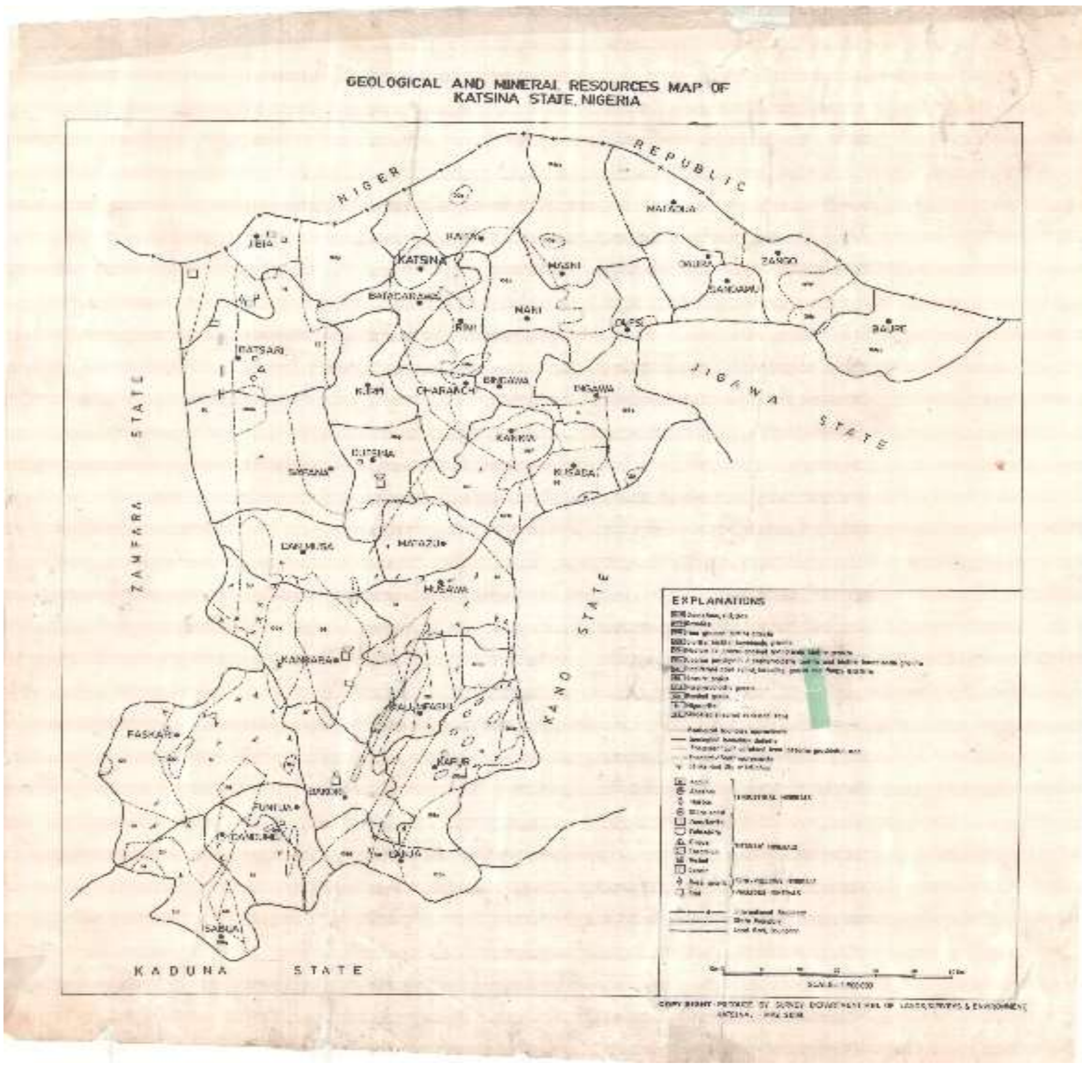

Fig 2: Geological Map of Katsina State.

The migmatites and gneiss represent the oldest rocks in the basement complex (Kogbe, 1976b). There are at least two generations of migmatitic gneiss of widely different ages within the study area. The migmatitic gneiss underly mica schist, dipping south-east at between 270 and 430 with most outcrops observed in stream channels. The mica schists are generally fissile dark-grey to greenish grey in colour and weather to a silvery to a light grey colour with red iron- oxide stains on its fissile surfaces.

MATERIALS AND METHODS

Reconnaissance survey was done in the study areas in 2015 and 2016 to ascertain the possible work done by a drilling company from the Republic of Zcheck in 1980. The drilling was done using Wenner's Array method that exploited Aquifers within the region laterally and which also determine its Resistivity Profile (RP), and the Schlumberger Array method that exploited the Aquifers vertically, which also determine the Vertical Electrical Sounding (VES) Twenty (20) samples were collected from within the Local Government areas and analyzed in the Laboratory.

RESULTS

Table 1a: Groundwater Sample Results.

S/No	Parameters	L_1	L_2	L_3	L_4	L_5	L_6	L_7
1	Manganese(mg/l)	0.8	0.2	1.0	0.2	0.3	0.4	0.7
2	Nitrate (mg/l)	10.4	13.7	16.8	26.9	10.3	25.5	Nil
3	Phosphate (mg/l)	0.04	0.47	0.28	0.22	0.47	0.40	0.17
4	TDS (PPM)	2.2	3.2	4.2	3.8	3.2	6.4	6.2
5	Fluoride (mg/l)	1.29	0.71	2.25	1.93	3.70	2.26	0.56
6	Temperature (°c)	28	27	26	27	27	24	26
7	Sulphate (mg/l)	7.0	5.0	2.0	4.0	6.0	23	35
8	Turbidity (FAU)	20	30	88	258	24	412	21
9	Chlorine (mg/l)	0.38	1.11	0.33	0.12	0.01	0.06	0.17
10	Iodine (mg/l)	4.44	0.54	0.29	0.34	0.21	0.16	0.28
11	Nitrite (mg/l)	0.033	0.040	0.031	0.057	0.042	Nil	0.043

Table 1b: Groundwater Sample Results (Continuation).

S/No	Parameters	L_8	L_9	L_{10}	L_{11}	L_{12}	L_{13}	L_{14}
1	Manganese(mg/l)	0.7	2.5	0.4	0.1	0.8	0.7	0.5
2	Nitrate (mg/l)	34.4	12.3	16.0	Nil	Nil	Nil	Nil
3	Phosphate (mg/l)	0.11	0.31	0.26	1.02	0.045	0.19	0.15
4	TDS (PPM)	6.2	6.4	6.4	6.2	6.8	5.2	5.8
5	Fluoride (mg/l)	2.60	1.68	2.72	0.64	0.72	0.60	0.86
6	Temperature (°c)	24	24	26	28	28	28	28
7	Sulphate (mg/l)	41	42	36	62	45	Nil	Nil
8	Turbidity (FAU)	204	4	10	196	93	11	93
9	Chlorine (mg/l)	0.03	0.01	0.05	0.24	0.09	Nil	0.15
10	Iodine (mg/l)	0.31	0.45	0.12	0.54	0.66	0.09	0.38
11	Nitrite (mg/l)	0.058	0.085	0.082	0.058	0.031	0.061	0.054

Table 1c: Groundwater Sample Results (Continuation).

S/No	Parameters	L_{15}	L_{16}	L_{17}	L_{18}	L_{19}	L_{20}
1	Manganese(mg/l)	0.5	1.9	0.1	0.6	0.6	0.4
2	Nitrate (mg/l)	32.3	23.4	30.8	Nil	Nil	Nil
3	Phosphate (mg/l)	0.66	0.11	0.10	0.11	0.28	0.26
4	TDS (PPM)	6.1	6.2	6.2	6.3	6.0	6.2
5	Fluoride (mg/l)	0.93	0.59	0.18	0.89	0.23	0.65
6	Temperature (°c)	28	26	26	27	27	27
7	Sulphate (mg/l)	14	Nil	Nil	35	Nil	Nil
8	Turbidity (FAU)	55	28	16	87	40	30
9	Chlorine (mg/l)	0.10	0.20	0.24	0.10	0.01	0.06
10	Iodine (mg/l)	0.51	0.16	0.07	0.23	0.52	0.07
11	Nitrite (mg/l)	0.066	0.041	0.035	0.028	0.032	0.009

Source: Fieldwork March, 2015.

Table 3: Presentation of Results and Findings.

S/No	Parameter	Unit	Standards		N	Descriptive Statistics		
			SON	WHO		Range	Minimum	Maximum
1	Manganese	mg/l	0.0	0.1	20	2.4	0.1	2.5
2	Nitrate	mg/l	50	50	20	34.4	00.0	34.4
3	Phosphate	mg/l			20	0.98	0.04	1.02
4	TDS	Ppm	500	500	20	4.6	2.2	6.8
5	Fluoride	mg/l	1.5	1.5	20	3.47	0.23	3.70
6	Temperature	^{0}c	Ambient	29	20	2	26	28
7	Sulphate	mg/l	100	250	20	62	0.0	62
8	Turbidity	FAU	5	5	20	408	4	412
9	Chlorine	mg/l		5	20	1.11	0.00	1.11
10	Iodine	mg/l		No guideline	20	4.37	0.07	4.44
11	Nitrite	mg/l	0.2		20	0.085	0.000	0.085

Source: Fieldwork March, 2015.

DISCUSSION AND CONCLUSION

Physical Parameters: The physical characteristics of samples analyzed are temperature and turbidity (see Tables 1a, 1b and 1c) In case of the temperature measured, all the samples met WHO standard, which has limit of 29^{0}c. On the other hand, the temperature of the measured samples exceeded beyond 25^{0}c as recommended by SON, except that of L_6, L_7 and L_9 which were found within SON standard. Here it can be said that 100% of the samples were found within the WHO standards. While, only 15% of the samples were found within SON standard.

However, the turbidity of the samples was found to be above the Nigeria Standard for Domestic Water Quality (NSDWQ) as only 5% of the samples was found within the recommended limit of both SON and WHO (Tables 2 and 3)

Chemical Parameters**:** The analysis conducted under this parameter are: Manganese, Nitrate, Phosphate, TDS, Fluoride, Sulphate, Chlorine, Iodine and Nitrite.

All the samples analyzed for Nitrate, TDS, Sulphate, Chlorine and Nitrite were found within the recommended limit of both SON and WHO. The low Nitrate, TDS, Sulphate, Chlorine and Nitrite contents indicate that the water has no laxative effect. In addition, we it can be said that 100% of the samples analyzed under the above mentioned chemical parameters, were found within standards of both SON and WHO. We can add that, the factors which lead to the leaching of both Nitrate and Nitrite into the water table such as soil type, geology, crop utilization rate of nitrogen, microbal conversion rate of Nitrate and fertilizer application pattern were completely dormant in the study area, due to little or no agricultural activities take place. Thus, it can be deduced that relatively high Nitrate and Nitrite values may be due to leaching from sewages pit latrines and refuse dump located close to the wells.

For Manganese concentration, 90% of the samples analyzed were found to be above the recommended limit of WHO which is 0.1mg/l, while 80% of the samples exceeded the recommended limit of SON which is 0.2mg/l. when the value of Manganese exceed the recommended limit, the users of such water experience neurological disorder (SON, 2007). In terms of phosphate concentration, no any known specified limit stated by both SON and WHO, but some information sourced from water, water everywhere in 1983, stated that the Phosphate concentration should not exceed beyond 0.1mg/l. By using this information it is said that 85% of the samples were found above 0.1mg/l and only 15% were found within the recommended limit of the mentioned organization. Phosphates are not toxic to people or animals unless they are present in very high level. Digestive problems could occur from extremely high level of Phosphate (APHA 1995).

The result of Fluoride analysis that, 35% of the samples were found to be above the recommended limit of both SON and WHO which is 1.5mg/l. The high concentration Fluoride (especially above the recommended limit mentioned above) will lead to Fluorosis, skeletal tissue bones and teeth morbidity (SON, 2007). There is no guideline for Iodine concentration in drinking water, though it is a micro element which is required in small quantity as it is useful to man.

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