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GEOCHEMISTRY ASSESSMENT OF GROUNDWATER QUALITY AND ROCK TYPES WITHIN LANGTANG, NIGERIA.

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ABSTRACT
Geological field mapping on a scale of 1:12,500 on Wase Sheet 191 NW, was undertaken to determine the rock types and groundwater quality assessment within Langtang area, Nigeria. Rock samples were collected at various points and the coordinates were taken using the Global Positioning System (GPS) device. The samples were physically observed in the field and afterwards transported to the lab for thin section production and petrographic studies. Thin sections were observed under a petrological microscope in cross and polarized light and the minerals were described as shown in plates. The geological field mapping revealed that the area is made up of four (4) major rock types; Pan African older Granites, Migmatite-gneiss, Alluvium, and Agwu Formation. Analysis of water samples from the study area shows that major cations; Ca^{2+} had a value range of 1.053 to 60.346 mg/L, Mg^{2+} with values of 1.424 to 60.346 mg/L, Na^{+} had values of 0.212 to 2.66, and K^{+} with a value range of 2.13 to 27.22 mg/L. While the Anions; NO_3^{-} ranged from 0.56 to 87.52 mg/L, SO_4^{-} with values of 0.00 to 3.2 mg/L, HCO_3^{-} with values of 0.00 to 4.7 mg/L, and F ranged from 0.35 to 3.47 mg/L. The pH value averaged at 6.4, Temperature 26.5° C, and EC 681.96 µS/cm. The Piper Trilinear Plot, Stiff and Durov plots classified the water of the study area into three major types: Ca-Mg-HCO_3, Na-HCO_3 and Ca-Mg-SO_4. The water quality and Geochemistry of the rocks of the study area show that fluoride is leached from biotite granite into the ground water (through weathering processes), thereby raising the levels above acceptable limits.

KEYWORDS: *Geochemistry, Groundwater quality, fluoride, and Langtang.*

1.0 INTRODUCTION

Fresh water quality and accessibility remains one of the biggest environmental and sustainability challenges of the twenty first century (UNEP, 2002). Out of 100 % available fresh water on earth, 90 % of it is trapped underground as ground water sources, Mishra (2023). The role of water as a vital resource to survival of humans cannot be overemphasized; ground water is the main source for both domestic and industrial use in Nigeria. Groundwater is an economic resource and more than 85 % of the public consumption is obtained from the ground. According to Ishaku (2011) groundwa-

ter quality status and the determination for human use is very vital for the sustenance of human populations. Groundwater is a very important natural resource. It is the primary source of drinking water for half of the world population, Margat and Van der Gun (2013). Groundwater is also vital for agriculture as it contribute to more than 50 % of the world production of irrigated crops (Bates *et al*., 2008). Water as a resource is increasingly coming under pressure from changes in land-use, increased demand for water supply from an increase in population and climate variability. Studies have shown that the gap between freshwater supply and demand will widen during the coming century because of these changes and because of the increasing consumption of water by a growing human population (Bates *et al.,* 2008). In many regions of the world, the amount and quality of water available to meet this growing need are already limited, Pittock and Finlayson (2011).

In most rural communities in Northern Nigeria, the supply of water for drinking and other purposes is solely from surface (ponds, streams, and rivers) and groundwater (other sources may include hand dug wells and boreholes). Very often the qualities of such waters destined for human consumption are not known, however research have shown that the deterioration of water quality can be either natural (geogenic) or human induced (anthropogenic), the former is largely responsible for the presence of fluoride in groundwater as a result of weathering (chemical) and leaching of rock forming minerals into the ground. Eduvie and Olaniyan (2013) reported their findings on water quality of some parts of southern Kaduna (part of the Basement Complex of Nigeria) by sampling and analyzing forty samples in the lab for physical, chemical and bacteriological parameters. The results show a low total mineralization, except for some hand dug wells sited close to dump sites and latrines in the study area and the bacteriological result show some E-coli growth suggesting human fecal link.

Elevated levels of fluoride in groundwater >1.5 mg/L (WHO and Nigerian Standard for Drinking Water Quality guidelines 0.5 to 1.5 mg/L) can cause skeletal and dental fluorosis in adults and mottled teeth in young people. Other harmful effects associated with fluoride in drinking water are reduced IQ, neurological disorder, hip fractures in women and, endocrine effect (Dissanayake, 1991). Fluoride enters the human body mainly through drinking water (Dissanayake, 1991), other sources may be from certain foods, dust, and industrial exposure. Availability of fluoride in groundwater indicates various geochemical processes and subsurface contamination of a particular area. Fluoride-bearing aquifers, geological factors, rate of weathering, ion-exchange reaction, residence time and leaching of subsurface contaminants are major responsible factors for availability of fluoride in groundwater, Mukherjee and Singh (2018).

The sources from which fluoride gets into ground water are basically from minerals that contain fluorine such as biotite from granitic rocks, such as fluorite, Fluoro-apatite, cryolite, hydroxyl apatite, biotite, hornblende among others. The presence of fluoride is mostly localized in their geological setting. The highest concentrations are found in acid magmatic rocks, mineralized veins, and sedimentary formations where biogeochemical reactions have taken place (Smedley *et al*., 2007). On weathering, fluorine seems to be let out preferentially from minerals where biotite and amphiboles are abundant such as in granites, major sources of fluoride in water bodies are formed. In sedimentary rocks apatite may be an acces-

sory mineral contributing fluoride to water while fluorite may be cementing materials in sandstones. Intake of fluoride in groundwater is commonly noticeable among the natives within the Langtang area as dental caries and skeletal fluorosis (Dibal *et al.*, 2016, Wongdem *et al.*, 2002).

2.0 MATERIALS AND METHODS

2.1 Study Area

The study area is located in the lowlands of the Jos Plateau and forms part of Wase Sheet 191 NW. It is bounded by latitudes 9°00'30.2" N and 9°14'39.0" N and longitudes 9°42'0" E and 9°54'0" E. The study area displays a typical lowland landscape of low elevations (ranging from 200 to 600 meters above sea level), with scattered shrubs and undulating grassland. The plains are drained by meandering rivers and streams in shallow valleys. Apart from the large body of the rhyolite on the western portion of the mapped area, several minor flows of the rhyolite occur as boulder on the porphyritic biotite-granite complex and the migmatite are common within fractures of these rocks. The southern portion of the map is covered by migmatites with boulders of porphrytic granites and a clear boundary between the basement and sedimentary environments is observed along the bridge before Zamko town located on the southeastern part of the study area which stretches down to Mban and onwards to Langtang South LGA. This sedimentary boundary has been rarely observed and studied by this research work, and although the geology of the Benue Trough of Nigeria is well known and documented, much is not known about its extent to this study area. Pegmatitic dykes are visibly seen striking through the migmatite-gneiss rock massifs. The study area is drained by the river Kaplak to the southeast of the study area and Bapkwai river to the southwestern portions which takes its source from the Warrock-Gazum hills to the north side of the study area and meanders down to the plains flowing down to the southeast direction. There are other small streams and rivers that line the entire landscape which drains the area and all trending in a NE-SW direction, maintaining a dendritic flow pattern, and most of the rivers are seasonally drained.

In hydrogeological terms, groundwater occurs in three types of aquifers; alluvium that are recently deposited which flows along river and stream flood plains or channel (alluvial sands aquifer), weathered regolith and deformed basement aquifer. Groundwater is intercepted in the alluvial aquifer at 4–5 m, and 8–12 m in the weathered regolith Aquifer and between 30–35 m in the deformed basement Aquifer. Most of the hand dug wells dry up in the peak dry season, inhabitants or rural dwellers make use of dried riverbeds to scoop up water for drinking from the ground.

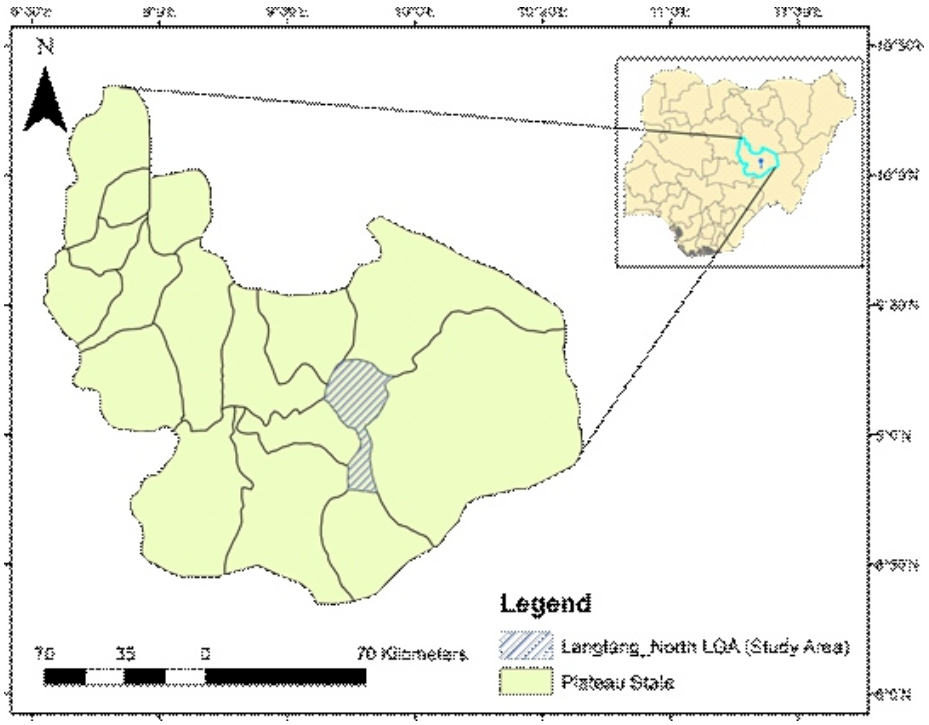

Figure 1. Map of study Area

2.2 Materials

The materials used for this work include.
topographic base map

- geological hammer,
- sample bags,
- field notebooks,
- water-proof marker pens
- GPS device
- water sample bottles, pipet and concentrate Hydrochloric Acid (HCl)
- pH meter,
- Electrical conductivity and TDS meter, thermometer, measuring tape etc.

2.3 Methods

2.3.1 Laboratory Analysis of Water Samples

The thin Sections were prepared in the Thin Section laboratory of the Department of Geology University of Jos, and Water samples taken to Lab of the National Fertilizer Development Centre Kaduna for water quality analysis.

Water samples were collected to determine the groundwater quality and other parameters in hand dug wells, boreholes, a pond, and dam. Hydrogen exponent (pH), EC, and temperature were determined in the field by a pH/Temp/ meter. Geological mapping of the area was carried out on a scale of 1:12,500. Rocks samples were collected during the field mapping exercise at different points and from several rock units such as porphyritic biotite granite, migmatite gneiss, fine to medium grained biotite granite, pegmatite, and quartzite, out of which representative samples were selected for thin section analysis.

The acidified water samples from the field were taken to the National Fertilizer Development Center Kaduna, soil and water testing lab and analysed for parameters such as, Ca, Mg, Na, K, HCO_3^-, Cl, CO_3^{2-}, SO_4^{2-}, NO_3^-, (to enable proper description and determination of the groundwater type in the study area) and Fluoride. The procedure and method used for the analysis is given in the Table below:

Table 1: Laboratory Procedure for Environmental Water Quality *(source: UNEP 2004)*

PARAMETERS	METHOD DESCRIPTION	UNITS
Electrical Conductance	pH/EC/TDS/Temperature model Mi 806 combined meter. The specific conductance is measured by a conductivity meter with Pt electrodes and is equilibrated to 25°C before the sample measurement is made. The conductivity meter is calibrated on a per use basis.	µS/cm
Total Dissolved Solids	pH/EC/TDS/Temperature model Mi 806 combined meter. The TDS is measured through a calibrated conductivity meter with a resolution of 3 significant figures or 1 mg/L and the range is between 0 and 19900 mg/L.	mg/L
Temperature	The water temperature was measured in the field using the Mi806 combined pH/EC/TDS/Temp combined meter.	°C
pH	pH/EC/TDS/Temperature model Mi 806 combined meter. The procedure for measurement is same as above	pH Units
Bicarbonate	Calculated Pipette 20 ml of water sample into a 100 ml conical flask, add few drops of phenolphthalein indicator, if a pink colour appears titrate slowly with 0.02N H_2SO_4 from a burette until the pink colour disappears. Record the volume of 0.02N H_2SO_4 used for CO_3. Into the same flask add few drops of methyl orange; titrate with 0.02N H_2SO_4 to reddish end point. Record titre to HCO_3	mg/L HCO_3
Nitrate	Nitrate ion selective meter was used for the analysis. The meter electrode is dipped in a sample inside a beaker; the readings are observed and written down.	mg/L N NO_3
Sodium	Flame Photometry The sample is mixed with lithium nitrate and passed into the burner of a flame photometer equipped with filters to separate the spectral lines of sodium. The intensity of light produced is proportional to the concentration of sodium in the sample and compared to identical standard and blank solutions, already prepared using Propane and air flame. The method detection limit is 0.1 mg/L.	mg/L Na
Magnesium	Atomic Absorption Spectrometry – Pipette or measure 50 mls water sample into a 100 ml beaker, add 10 ml of Nitric acid. Place beaker and content on a hot plate and digest till when brown fumes of Nitric acid have escaped. Continue heating till when content have reduced to 10 ml volume. Wash content to a 50 ml volumetric flask and make to mark, keep digest for the determination of Mg with the Atomic Absorption Spectrophotometer (AAS). The method detection limit is 0.001 mgL.	mg/L Mg
Sulphate	Turbidimetric Method Pipette 2-5 of clear sample of water into a 50 ml volumetric flask. Add 5 ml of 50% acetic acid and 1 ml of H_3PO_4, swirl the flask to mix the solution. Make content to 45 ml volume. Add 1 ml of Barium chloride crystals. Allow flask to stand for 10 minutes without shaking. Invert the flask twice and all to stand for 5 minutes. Repeat step above three to four times. Add 1 ml of gum acacia solution and make to mark of 50 ml volume with distilled water, shake and allow to stand for 90 minutes. Measure turbidity at 470 nm on a spectrophotometer. Run a blank sample the same manner. The method detection limit is 1 mg/L.	
Chloride – Dissolved	Argentometric method To 20 ml of water sample in 250 ml flask add 3 drops 0f 5% $K_2Cr_2O_7$ indicator. Titrate with standard $AgNO_3$ to first permanent reddish-brown colour. Calculate Cl mg/L = (AxAx70900)/mls of samples.	mg/L Cl

Potassium	Flame Photometry: The sample aliquot is mixed with a lithium nitrate solution, as an internal standard, and passed through the burner of a flame photometer equipped with interference filters isolating the spectral lines of potassium. The intensity of light produced is proportional to the amount of potassium present in the sample and is compared to identically prepared standard and blank solutions, using propane and oxygen flame. The method detection limit is 0.1 mg/L.	mg/L K
Calcium	Atomic Absorption Spectrometry Pipette or measure 50 mls water sample into a 100 ml beaker, add 10 ml of Nitric acid. Place beaker and content on a hot plate and digest till when brown fumes of Nitric acid have escaped. Continue heating till when content have reduced to 10 ml volume. Wash content to a 50 ml volumetric flask and make to mark, keep digest for the determination of Mg with the Atomic Absorption Spectrophotometer (AAS). The method detection limit is 0.001 mg/L.	mg/L Ca

2.3.2 Petrographic Analysis of rock samples:

Rock samples were taken at various locations within the study area and labelled and were later taken to the thin section laboratory for preparation. Samples were observed under the microscope in both cross and polarized light. They are as presented below as Plate I, II, II, IV, in the preceding section.

3.0 RESULTS AND DISCUSSION

3.1 Petrography

The study area is largely underlain by the older granites within the basement complex with visible massive outcrops of granitic rocks seen on the north and central parts of the study area. There are outcrops of Quartzite hills on the northeastern flank of the study area around Zambau village. Also observed, are some out crop of Dolorite rocks in Zakbai, which belongs to the Jurassic age. On the southeastern portion of the study area are alluvium of the upper Benue sedimentary basin with a sharp distinct boundary around Zamko. (Figure 2)

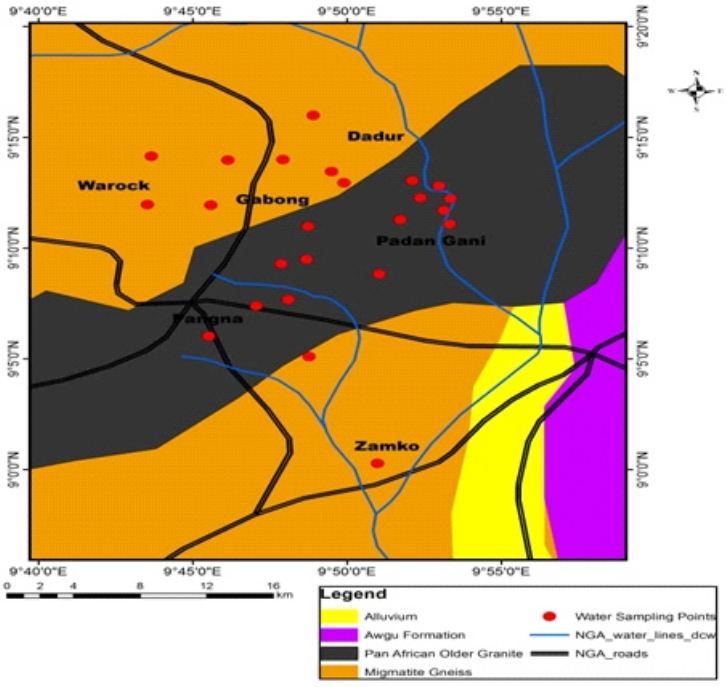

Figure 2: Geological Map of Study Area showing water sampling points.

3.1.1 Sample HAZ 23 (Older Granites)

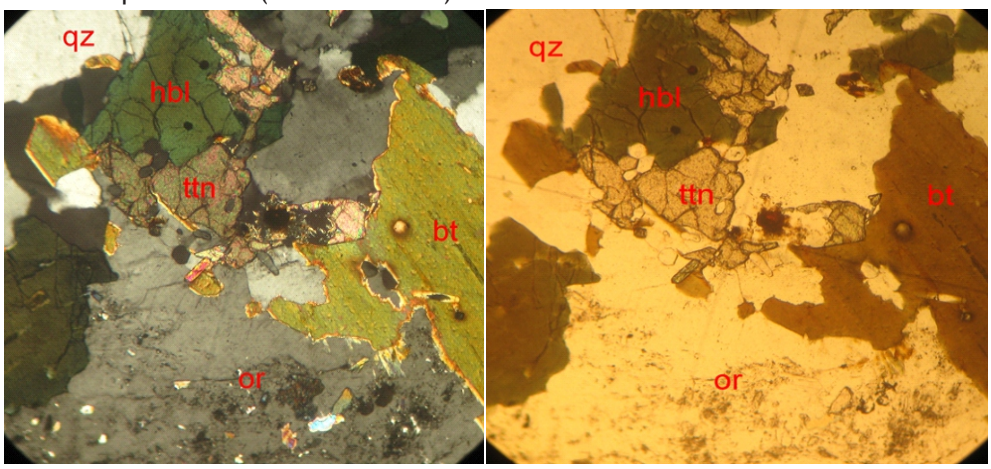

Plate 1: Photomicrograph of Older Granite rock under cross and polarised lights

This sample contains the minerals quartz, plagioclase, biotite, and muscovite micas. The quartz has a high relief and appears clear in plane polarized light. It is characterized by conchoidal fractures and unloose extinction resulting from strain in the crystal structure. Biotite micas show pleochroic colors from light brown to dark brown. It also shows shades of green and yellow and extinction parallel to the mica cleavage. The mineral is undergoing extensive weathering and sericitisation thereby creating pore spaces within the cleavage planes and has quartz inclusions. Their appearance is cloudy because of alteration. Plagioclase feldspars have low relief with a diagnostic lamellar twinning. They are also highly altered creating pore spaces within the cleavage planes. Microcline is seen with distinctive x-hatch twinning and is highly weathered. This is a granitic rock as shown on Plate 1: above.

3.1.2 Sample HAZ 25 (Dolorite)

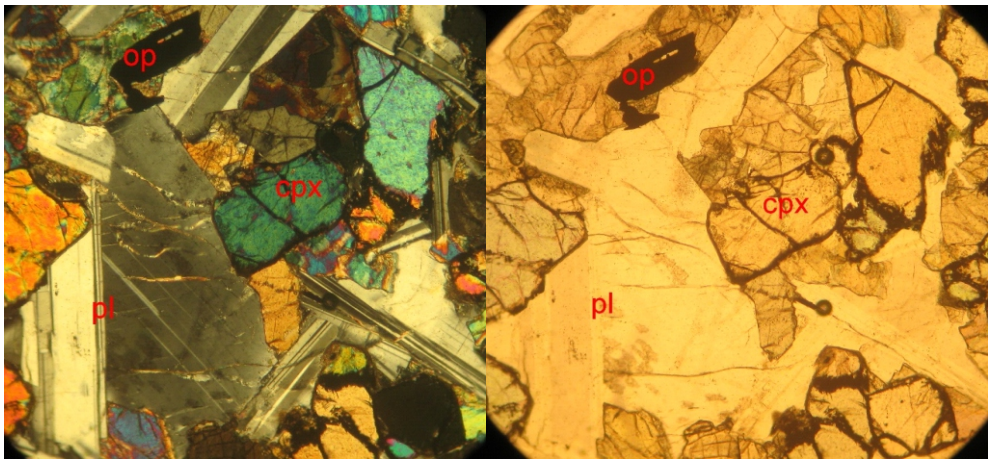

Plate 2: Photomicrograph of Dolorite under plain and polarised lights

This rock is made up predominantly of plagioclase feldspar and subordinate pyroxenes and olivines as shown on Plate 2 above. The plagioclase which is ubiquitous occurs as laths and is characterized by diagnostic albite twinning. The olivines are characterised by fractures and pleochroic greenish to brownish color. Pyroxene occurs typically colourless to pale brown to pale green in plane light. It has two directional cleavages that intersect at 90^0. It shows pleochroic colors in shades of pink, green and, blue.

3.1.3 Sample HAZ DO2 (Dolorite dyke)

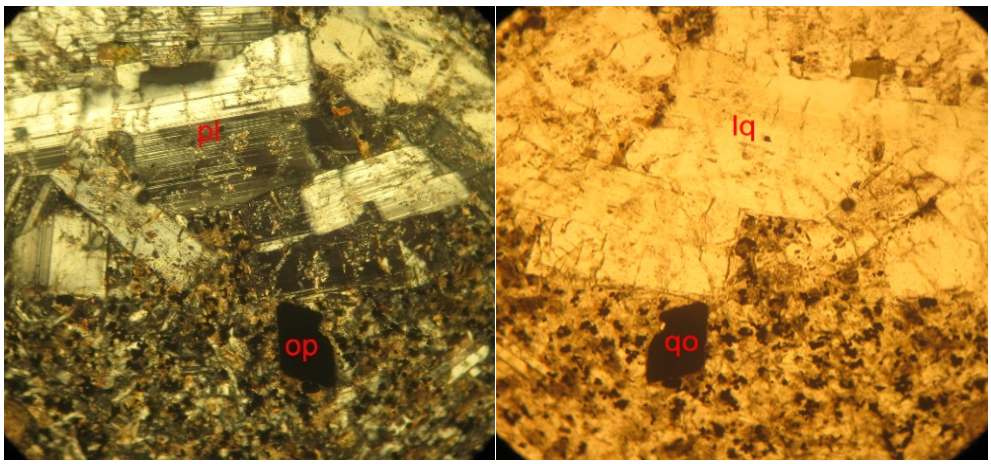

Plate 3: Dolorite dyke under plain and polarised lights

This sample contains large phenocrysts of the mineral plagioclase in groundmass of other minerals. The mineral pyroxene shows pleochroic colors of pink, green, and blue and a 2-directional cleavage that intersects at 90^0. The pyroxene shows zoning with dispersed opaque minerals as displayed on (Plate 3) above.

3.1.4 Sample HAZ 15 (Granitic rock)

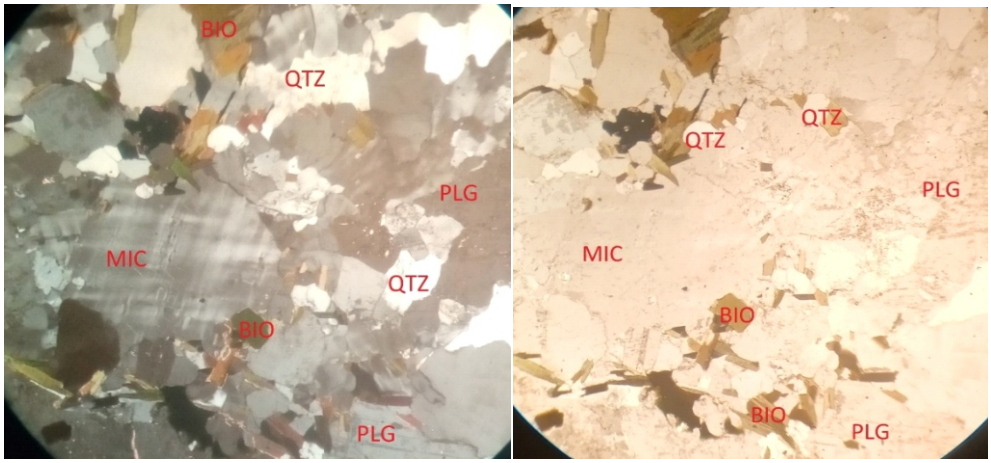

Plate 4: Photomicrograph of Biotite Granite under plain and polarised lights

Sample HAZ 15 is composed of the quartz, plagioclase, biotite, microcline, and muscovite minerals. The quartz grains occur as clear crystals with high relief and fractured, while the biotite is seen in shades of brown and dark brown in plane light. It shows pleochroic colors of green and yellow. Microcline is colorless and has low relief in plane polarised light. It has a well-developed x- hatch twinning which is diagnostic of microcline. The lamellae have a spindle shape (thick and thin along its length) which distinguishes it from plagioclase.

Plagioclase appears colourless with low relief compared to quartz under plane light. Its dominant feature is the lamellar twinning (albite twinning). It also shows Carlsbad twinning. The lamellar twinning observed in plagioclase is constant as opposed to the pinch and swell in microcline with a dusty appearance because of its alteration, see Plate 4. above.

3.2 Water quality analysis

Table 2. Physical and Chemical parameters of the groundwater of Langtang Area

	SAMPLE NAME	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	NO_3 (mg/l)	SO_4 (mg/l)	CO_3 (mg/l)	HCO_3 (mg/l)	F (mg/l)	pH	EC (µs/cm)	T° (°c)	TDS (ppm)	Cl (mg/l)
1	WSL-1	1.053	1.424	0.346	4.10	5.57	0.00	0.00	0.70	0.45	6.6	121	17	060	155.98
2	WSL-2	18.629	3.478	0.384	16.03	0.94	2.00	0.40	2.20	2.56	7.0	232	20	119	382.86
3	WSL-3	30.738	10.512	0.484	52.00	25.63	0.00	1.00	1.80	1.87	6.8	622	23	309	389.95
4	WSL-4	17.602	9.594	0.461	21.98	35.00	0.00	0.80	1.50	1.46	6.4	561	29	280	170.16
5	WSL-5	20.217	6.302	0.768	6.05	51.25	0.00	0.20	2.80	1.43	6.8	382	24	189	141.80
6	WSL-6	35.442	9.870	1.807	3.00	46.25	2.20	1.00	4.40	0.78	6.5	838	28	417	191.43
7	WSL-7	25.821	9.888	0.545	2.13	58.75	1.00	0.60	2.90	0.59	6.6	560	27	282	155.98
8	WSL-8	30.171	12.506	1.155	5.02	81.25	0.81	0.80	3.40	0.44	6.4	952	27	477	205.61
9	WSL-9	17.715	5.311	0.317	8.00	5.75	0.00	0.00	1.10	0.63	6.6	377	24	184	276.51
10	WSL-10	24.643	9.559	1.188	8.98	26.88	0.08	1.00	3.70	1.58	6.1	680	30	341	198.52
11	WSL-11	4.034	2.029	0.284	7.04	1.38	0.09	0.00	0.00	1.24	6.4	190	29	95	510.48
12	WSL-12	18.211	8.351	1.910	5.19	68.75	0.06	1.00	4.00	1.56	6.2	827	29	410	141.80
13	WSL-13	21.134	6.741	1.121	8.01	34.38	0.00	0.60	2.70	1.68	6.5	676	26	337	177.25
14	WSL-14	18.282	8.791	1.533	6.14	55.00	0.80	1.00	3.10	1.45	6.2	677	29	335	141.80
15	WSL-15	5.149	3.065	0.287	8.00	0.56	0.00	0.00	0.00	0.36	5.7	207	25	105	467.94
16	WSL-16	5.620	2.463	0.438	4.00	58.13	0.02	0.60	2.20	0.78	6.0	404	25	206	134.71
17	WSL-17	3.729	2.897	0.371	4.95	24.38	0.00	0.00	1.30	0.35	6.2	260	26	129	113.44
18	WSL-18	44.112	11.316	0.880	13.00	43.13	3.00	0.60	3.60	0.56	5.8	1452	28	697	333.23
19	WSL-19	60.346	16.095	2.660	27.22	137.5	3.20	0.80	3.30	0.48	6.6	2640	28	1327	631.01
20	WSL-20	17.317	8.850	0.212	6.16	53.75	0.07	0.00	3.50	0.38	6.3	588	28	292	148.89
21	WSL-21	30.647	10.391	0.307	8.00	68.76	0.08	0.60	2.10	0.45	6.2	665	28	333	205.61
22	WSL-22	14.877	10.353	0.596	7.44	37.54	0.00	0.80	2.60	0.56	6.6	593	28	297	113.44
23	WSL-23	4.231	10.721	0.988	4.96	31.25	0.00	1.00	4.70	0.87	6.6	746	29	377	127.62
24	WSL-24	32.785	11.353	0.571	7.20	87.52	0.00	0.40	4.50	1.86	6.1	749	30	310	134.71
25	WSL-25	41.352	11.754	0.929	16.00	50.00	1.50	0.10	2.70	3.47	6.5	1050	27	525	233.97

Table 3: Groundwater sampling points and coordinates

BH #	Easting	Northing
BH1	E009°47'03.6"	N09°7'23.7"
BH2	E009°45'31.0"	N09°06'01.2"
BH3	E009°47'39.5"	N09°3'24.1"
BH4	E009°50'58.8"	N09°00'16.3"
BH5	E009°48'45.8"	N09°05'06.2"
BH6	E009°48'05.5"	N09°07'39.9"
BH7	E009°47'51.6"	N09°09'17.2"
BH8	E009°48'40.9"	N09°09'29.0"
BH9	E009°51'02.5"	N09°8'49.4"
BH10	E009°53'19.0"	N09°11'04.9"
BH11	E009°53'20.9"	N09°12'13.6"
BH12	E009°53'08.1"	N09°11'42.1"
BH13	E009°52'22.1"	N09°12'16.2"
BH14	E009°52'06.7"	N09°13'02.1"
BH15	E009°43'31.8"	N09°11'57.8"
BH16	E009°43'39.2"	N09°14' 08.8"
BH17	E009°45'35.3"	N09°11' 56.4"
BH18	E009°46'08.2"	N09°13' 58.2"
BH19	E009°48' 54.2"	N09°15' 59.3"
BH20	E009°47' 55.2"	N09°13' 59.8"
BH21	E009°49' 29.6"	N09°13' 27.1"
BH22	E009°49' 54.0"	N09°12' 56.7"
BH23	E009°48' 43.8"	N09°10' 58.4"
BH24	E009°51' 43.3"	N09°11' 16.8"
BH25	E009°52' 8.4"	N09°12' 47.9"

3.2.1 Water classification of the study area

The water classification of the study area is based on a classification system suggested by Gorrell which considers the total concentration of dissolved solids. The total dissolved solids range as follows: Freshwater 0 – 1000 mg/l, brackish water 1000 – 10,000 mg/l, salty water 10,000 – 100,000 mg/l and brine greater 100,000 mg/l, while the TDS concentration based on the above classification falls far below the upper limit of the freshwater classification and the water is considered as freshwater.

3.2.2 Interpretation of Water Chemistry of study area

The chemical parameters of water samples from the 25 samples taken from open hand dug wells, ponds, stream channels, water reservoirs, hand-pump, and motorized boreholes analysed were plotted using a software package AquaChem, developed especially for graphical and numerical analysis and modeling of water quality data. The plot types used in this study includes:

Trilinear plot: Piper.
Durov diagram

I. Piper plot:

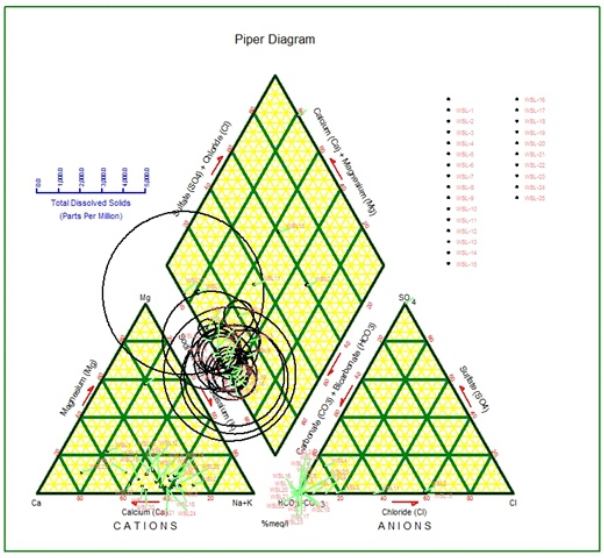

Figure 3: Piper Trilinear Diagram showing variation of milliequivalent percentages of major ions in water samples.

Piper plot here (Fig 3) shows that the groundwater of the area is slightly alkaline, and it can be seen from the figure that the waters are evolving from the Ca-HCO_3 to the Na-HCO_3 water type. Again, the major cations are evolving from Ca^+ to Na^++K^+, and the major anion HCO_3 + CO_3 dominating in the ground waters of Langtang area. Major groundwater types in the study area are:

Ca-Mg-HCO_3
Na-HCO_3
And Ca-Mg-SO_4

ii. The Durov Diagram

The Durov diagram is a popular visualization technique applied in hydrogeology to display the major ions as percentages of milli-equivalents in two ternary (trilinear) graphs that form an additional two-dimensional projection (the Durov projection Figure 4.4)

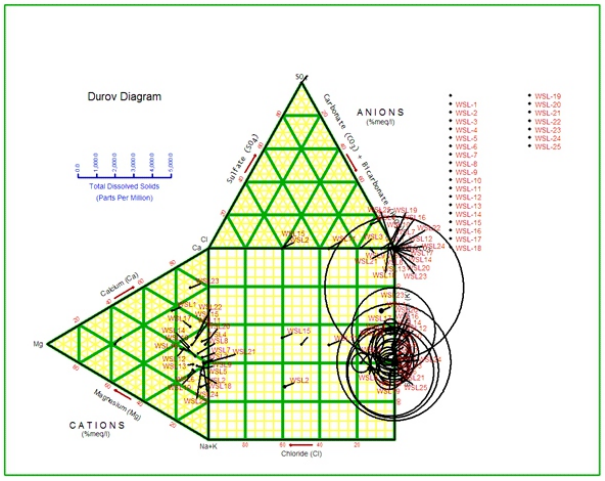

Figure 4: Durov diagram showing major ions as percentages of milliequivalents in two ternary (trilinear) graphs.

From the Durov diagram above it's clear that the dominant ions are the $HCO_3 - CO_3$ on the anion's percentage and the Na+K dominate the cations percentage. The variation of Na+K in the groundwater of the Langtang area is a result of the weathering of Coarse Porphyritic Biotite Granites rocks that contains feldspars and plagioclase minerals from which the Na^+-K^+ is leached into the groundwater.

Conclusion

Based on the results and discussions obtained from this research, the following conclusions were made, the geology of the area reveals four major rock types; Pan African Older Granites, Migmatite Gneiss, Alluvium, and Agwu Formation (the latter been sedimentary formations that forms part of the Upper Benue trough of the sedimentary basins of Nigeria). The high fluoride concentration of (3.47 mg/L) in the groundwater of the study area can be linked to the Geochemistry of the rocks, which comprised mainly Pan African Granites with the associated rocks such as coarse porphyritic biotite granites, Rhyolites, Riebeckite Granites, and trachytes. The study also revealed three main groundwater types within the Langtang area: Ca-Mg-HCO_3, Na-HCO_3 and Ca-Mg-SO_4, based on Piper and Durov plots methods of analysis.

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