Assessment Of Groundwater Quality Around Kaltungo And Its Environs

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ASSESSMENT OF GROUNDWATER QUALITY AROUND KALTUNGO AND ITS ENVIRONS

BY

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A THESIS SUBMITTED TO THE GEOLOGY
PROGRAMME, SCHOOL OF SCIENCE,
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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF BACHELOR OF
TECHNOLOGY (HONS) IN APPLIED GEOLOGY

OCTOBER, 2006

DECLARATION

I hereby declare that this thesis was written by me and it is a record of my own research work. It has not been presented elsewhere. All sources of information are duly acknowledged by means of references.

07/11/06

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Date

The above declaration is confirmed by

09/4/26

Mr. Dieter Bassi
(Project Supervisor)

Date

CERTIFICATION

I certify that this research project was carried out by Collins Maishanu of Applied Geology programme, Abubakar Tafawa Balewa University Bauchi Nigeria and has met the requirements for the award of B. Tech (Hons) in Applied geology

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DEDICATION

This research project is dedicated to God Almighty and all my entire family members for their unquantifiable effort towards the success of my study.

ACKNOWLEDGMENT

My profound gratitude goes to Almighty God for his daily provision, protection, ability and strength granted to me throughout my period of stay in the university. I thank you Lord for all the wisdom and success you rendered to me.

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ABSTRACT

The study area Kaltungo town, constitute part of 1:50,000 (Sheet 173) Kaltungo N.E. It lies between latitude $9^{\circ}48^{I}\ 00^{II}$N and $9^{\circ}50^{I}\ 38^{II}$N and $11^{\circ}16^{I}\ 00^{II}$E and $11^{\circ}12^{I}\ 45^{II}$e. It covers an area of 28.7km^2 on a scale of 1:25,000. Bima Sandstone constitute about 75% of the geology which was deposited uncomformably on the Older Granite that constitute the main inlier in the study area. Samples collected for the research comprise 10 water samples from Hand dug wells and Boreholes, a rock sample was collected from Kaltungo hill, in order to assess the quality of ground water in area. The samples were subjected to geochemical analysis for cations and anions especially fluoride. The result was compared with the World Health Organization (WHO), National Agency for Food and Drug Administration and control (NAFDAC) and National Primary Drinking Water Regulation (NPDWR) standard levels. It was found that an abnormal concentration of fluoride, iron and nitrate within Kaltungo town was observed, specifically in Cross Sabon line and Okra area. This might be responsible for dental fluorosis, which is common in the area, this is a disease characterized by discolored, blackened, mottled and chalky teeth especially during child hood, when teeth is developing.

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ABSTRACT

The study area Kaltungo town, constitute part of 1:50,000 (Sheet 173) Kaltungo N.E. It lies between latitude 9°48' 00''N and 9°50' 38''N and 11°16' 00''E and 11°12' 45''E. It covers an area of 28.7km^2 on a scale of 1:25,000. Bima Sandstone constitute about 75% of the geology which was deposited uncomformably on the Older Granite that constitute the main inlier in the study area. Samples collected for the research comprise: 10 water samples from Hand dug wells and Boreholes, a rock sample was collected from Kaltungo hill, in order to assess the quality of ground water in area. The samples were subjected to geochemical analysis for cations and anions especially fluoride. The result was compared with the World Health Organization (WHO), National Agency for Food and Drug Administration and Control (NAFDAC) and National Primary Drinking Water Regulation (NPDWR) standard levels. It was found that an abnormal concentration of fluoride, iron and nitrate within Kaltungo town was observed, specifically in Cross Sabon line and Okra area. This might be responsible for dental fluorosis, which is common in the area, this is a disease characterized by discolored, blackened, mottled and chalky teeth especially during child hood, when teeth is developing.

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CHAPTER ONE

1.0 INTRODUCTION

Water is a necessity, a resource and a major factor in pollution problem. The quality of any water resource is its suitability for intended uses. The quality of any water resources depends on its physical, chemical and biological (bacteriological) characteristics which in turn depend on the geology of the area and impacts of human activities. Pollution of water resources occur when the quality of the water is degraded or its usefulness to humans and other organisms is impaired as a result of certain substances (Davis and Cornwell, 1988). It may also occur because of natural constituents of water due to geology of the area in which the water occurs (natural pollution) or the pollution may be caused by the impacts of human activities on the water resources (man made pollution).

Ground water was defined sensu stricto by Darvinskii, (1935) as the finely divided water in form of droplets which fills the void in rocks and is capable of flowing through these voids. Groundwater to that portion of the water beneath the surface of the earth that can be collected in wells, tunnels, or drainage galleries that flows naturally to the earth surface via seeps or springs. Ground water is a major source of water for many municipalities and industries and for irrigation.

The pollution of water constitutes one of the major important, difficult and complex problems confronting the Nigerian environmental health authorities. Dirty water is the world biggest health risk accounting.

For as much as 80% of diseases in developing countries is attributable to water problem. (W.H.O 1996) estimates that 1.7 billion people are living without adequate sanitation and that world wide. 10 million people die annually from polluted drinking water. There are likely to be 400million people suffering from schistosomiasis, 160 million with malaria and 30 million with onchocerciasis. All these disease can be water related although other environmental factors can also be important (W.H.O 1996).

Fluoride is a mineral that accurs naturally in the earth's crust, water and food as negatively charged ion (F^-) fluoride is considered a trace element because small amounts are present in the body (2.6g in adults). Water with high fluoride content is mostly found in calcium deficient groundwater in many basement aquifers such as gneiss and granite, in geothermal water and in some sedimentary basins (www who int/entity/en).

Groundwater with high fluoride concentration occurs in many areas of the world including large parts of Africa, China, the Middle East and southern Asia. One of the highest known fluoride belt occurs along lands from Eriteria to Malawi. There is another belt from Turkey through

Iraq, Iran, Afghanistan, India, Northern Thailand and China. The Americans and Japan hare similar belts (www. who. int/entity/en).

Fluoride is found in vegetables, fruits, tea and other crops. though water has the highest contributor to daily fluoride intake. Fluoride is also found in the atmosphere originating from dust of fluoride containing soil from gaseous industrial waste, from burning of coal fires in populated area and from gases of volcanic activity. Though fluoride in varying concentration is freely available in nature, most studies on fluoride intake have been done in developed countries (www. who. int/entity/en).

Usually, the most abundant cation constituent in water are calcium, magnesium and sodium. Potassium is present but usually in laver concentration than sodium. The abundant anion constituents consist of bicarbonate, sulphate and chloride. The cations and anions are believed to be in equilibrium with one another, hence the neutrality of most water. The major ions that are commonly analysed for domestic, agricultural and industrial use includes:- NO_3^-, PO_4^{3-}, $S0_4^{2-}$, F^-, CL^-, Ca^{2+}, Mg^{2+}, Cu^{2+} Fe (T) and Na^+. In Kaltungo area of Gombe state, excess intake of fluoride has shown various cases of dental fluorosis which is a disease characterized by discoloured, blackened, mottled or chalky teeth especially during adulthood , when teeth is developing. Also severe and permanent bone and joint deformation of skeletal fluorosis is associated with chronic intake of excess fluoride.

In this study, an attempt has been made to investigate the chemical quality of groundwater from hand-dug wells and boreholes in Kaltungo area of Gombe state and also the effects of the rocks in the area to determine the stability, of water for domestic as well as industrial uses in the area.

1.1 AIMS AND OBJECTIVES

The objectives and expected benefits of this research work include the following:

- To determine the hydrochemistry and the suitability of groundwater in Kaltungo area of Gombe state for human consumption.
- To determine the influence of lithology on hydro-chemistry of the study area
- To determine groundwater pollution sources and if possible come out with solutions to the problems
- To assess the impact of surrounding geology to high concentration of fluoride present in the area and its influence on living creatures especially human beings.
- To satisfy the partial requirement for award of B. Tech. Degree in Applied Geology of the Abubakar Tafawa Balewa University, Bauchi.

1.2 LOCATION, EXTENT AND ACCESSIBLITY

The study area Kaltungo town, constitute part of 1:0,000 (sheet 173) Kaltungo N.E. It lies between latitude $9^{\circ}48^{\prime}00^{\prime\prime}$ N and $9^{\circ}50^{\prime}38^{\prime\prime}$ N and longitude $11^{\circ}16^{\prime}00^{\prime\prime}$ E and $11^{\circ}12^{\prime}45^{\prime\prime}$ E. The work was carried out on a scale of 1:25, 000 and covers an area of about ($28.7km^2$). the location map of the study area is shown in Fig 1

The study area is accessible though a major tarred road that leads to Kaltungo township from Gombe town and it is interconnected mostly by footpaths and some motorable untarred roads and is accessible throughout the year.

1,3 RELIEF AND DRAINAGE

The area is of moderate to high relief. It is marked by isolated hills and sandstones cliffs towards the north eastern part. There are various hills peaks which stand out within this general elevation among which is the famous Kilang peak (4,242ft) Carter et al, 1963. Boulders and minor hills surround it. The prominent one being Kaltungo hill, Phillip's hill found between Kilang and Kaltungo town

The area is well drained by network of ephemeral rivers and streams, which gather most of the run-off from the hills. The drainage system exhibits a dendritic pattern and is dominated by river Kaltungo which flows from north-east to the south-west. The main river channel has a straight to slightly sinous coarse.

1.4 CLIMATE AND VEGETATION

The area is characterized by two distinct season, the wet and dry seasons. The wet season starts in May and ends in October while the dry season runs from November to late April. The average rainfall per year is 600-1000mm Carter et al, (1963) with average temperature of 31°C in the dry season and about 21°C in wet season. The highest temperature occur just before the rainy season begins and humidity is high in the raining season.

The area is also semi-arid environment characterized with sparse vegetation, stunted trees mostly kanje, with shrubs and thorny bushes at the stream banks.

1.5 SETTLEMENT AND LAND USE

The area is sparsely populated with the major villages aligned along motorable roads while the smaller ones are scattered in the interior of the mapped area.

The major land use in the area is farming the farmers practice shifting cultivation and crop rotation which enable soil fertility to be maintained. Farming is done mainly in the rainy season. The main agricultural produce are: guinea corn, millet, maize, groundnut and beans. They also grow cash crops such as cotton. During the dry season, farming is restricted to the flood plain of the major rivers and irrigated plots. They also keep herds of goats and cattle which supply them with milk and meat.

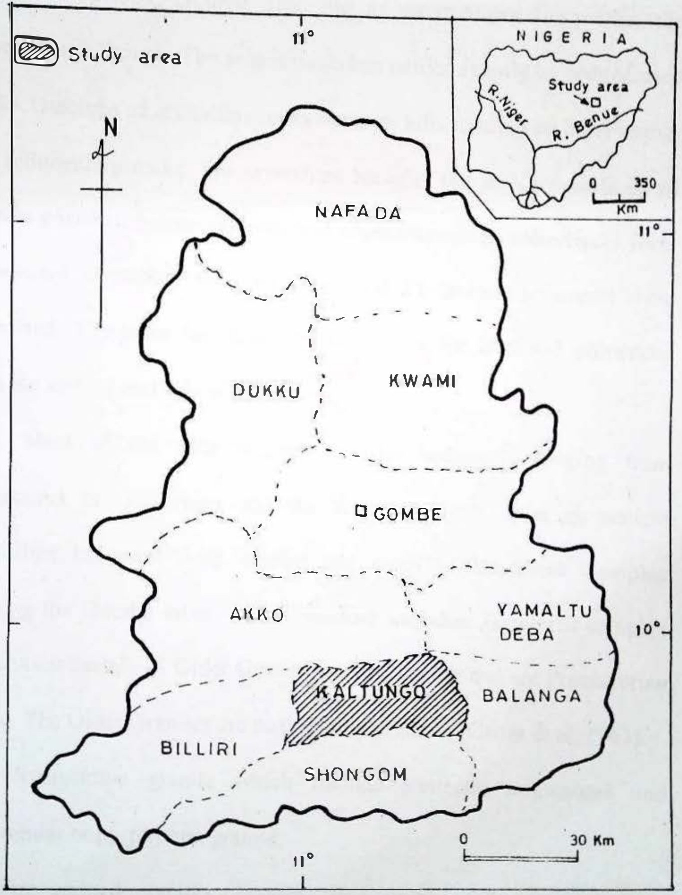


Fig. 1 Map of Gombe State showing the study area.

CHAPTER TWO

1.0 LITERATURE REVIEW

2.1 GEOLOGY OF GOMBE STATE

Geologically, Gombe state and its environment lies within the upper Benue Trough. The area is underlain predominantly by sedimentary rocks. Outcrops of crystalline rocks occur as hills forming an inlier within the sedimentary rocks. The crystalline rocks of the area are made up of granite-gneisses, biotite-gneisses and pegmatite which collectively form an ancient crystalline floor on which the Cretaceous sediments were deposited. The inlier has structural control on the area and influenced both the surface and subsurface drainage.

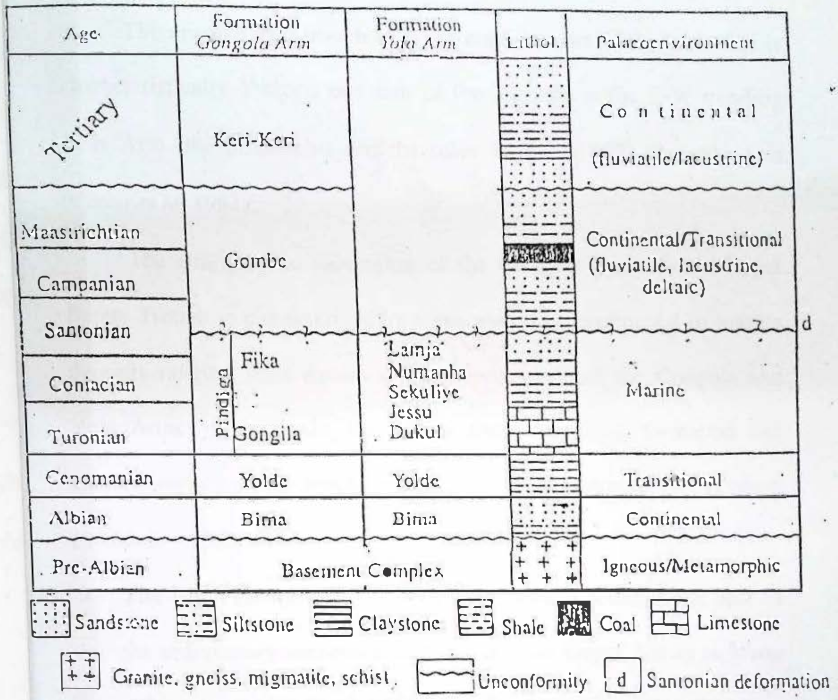
Most of the area is underlain by sediments ranging from Cretaceous to Quaternary and the formations rest upon an ancient crystalline basement with smaller out crops of Basement Complex forming the Gombe inlier. The formations includes: Basement complex this consist mainly of Older Granites and magnetite and are Precambrian in age. The Older Granites are further divider into 3 (Carter et al, 1963).

Syntectonic granite which include anatectic migmatites and equiangular or porphyritic granite:

- Fine grained granites occurring in a group of 2 minor intrusive bodies

- Basic and intermediate plutonic rocks (older) which are wide spread but individual occurrences are small

The stratigraphy of the Benue trough has been described by Reyment, (1965), who presented the stratigraphy of the different depositional basic in the country and created a large lithostratigraphic division. (Carter et al, (1963); Fayose, (1979); C.A Kogbe, 1972; Obaje et al, (1999); Akande et al, (1998) and others have all described the stratigraphy of the Benue Trough. The trough is generally divided into lower, middle and upper parts. The upper Benue trough is the focus of the study. The stratigraphy of the upper Benue trough is shown in Table 1.



Age	Formation *Gongola Arm*	Formation *Yola Arm*	Lithol.	Palaeoenvironment
Tertiary	Keri-Keri			Continental (fluviatile/lacustrine)
Maastrichtian	Gombe			Continental/Transitional (fluviatile, lacustrine, deltaic)
Campanian				
Santonian				d
Coniacian	Pindiga Fika	Lamja Numanha Sekuliye		Marine
Turonian	Gongila	Jessu Dukul		
Cenomanian	Yolde	Yolde		Transitional
Albian	Bima	Bima		Continental
Pre-Albian	Basement Complex			Igneous/Metamorphic

Sandstone, Siltstone, Claystone, Shale, Coal, Limestone

Granite, gneiss, migmatite, schist, Unconformity, d Santonian deformation

Table 1. Stratigraphic succession in the Upper Benue Trough (Modified after Obaje et (1999).

The upper Benue trough is in the northern part of the basin and is characteristically Y-shape one arm of the Y-shape is the E-W trending Yola Arm (the main arm) and the other is the N180°E Gongola Arm (Carter et al, 1963).

The stratigraphic succession of the Gongola Basin in the upper Benue Trough is characterized by a succession of continental to marine deposits ranging from Aptian to Paleocene. In both the Gongola and Yola Arms of the Basin, the Albian Bima Sandstone formation lies uncomformably on the Precambrian Basement. The stratigraphy is being envisaged as follows:

- **The Bima formation:** The Bima Sandstone is found at the base of the sedimentary succession and ranges from Upper Aptian to lower Albian age (Allix et al, 1981). The Sandstone formation ranges in thickness from 100m to 3000m, and has maximum development at the Lamurde anticline (Allix et al, 1981). In the area Bima Sandstone is divided into lower, middle and upper Bima members.

The Lower Bima member consist of highly friable units with overall thickness ranging from 0 to 1500meters. The Middle Bima member is composed of 300m to 1200m of coarse-grained sandstone with clays and shales in fining upward cycles each 5 to 10 meter thick. The Upper Bima member comprises of fine to coarse – grained sandstone characterized by tabular cross-bedding with relatively thick sets. The averaging thickness is 500meter reaching a maximum of 1500meters.

- **The Yolde Formation:** The Cenomanian Yolde formation lies conformably on the Bima sandstone, and represents the transition sequence between the continental Bima sandstone and the marine deposits of the lower part of the Pindiga formation. The lower sandstone-mudstone is interpreted to be of shore line-lagoonal origin. The upper portion with thinly and regularly bedded, bioturbated and with low diversity bivalves at the top is of shallow marine (Zaborski et al, 1998).
- **The Pindiga Formation:** The Pindiga formation comprises of the calcareous beds and day-shale deposits. It makes up the greater part of the upper Cretaceous deposits in the upper Benue trough. About 80meter of shaly mudstones with limestones intercalations are overlain by about 160meters of strata consisting of almost shaly mudstones with levels of bedded sandstones.
- **The Gongila Formation:** Falconer (1911) mentioned the locality 1 mile south of Gongila village where the limestone is clearly shown resting upon the lower series of white and red, sandstones and grits. The Gongila formation passed laterally to the east and to the south into the Pindiga formation, typical developments of which are found around Bara, Gulani and Balbaya.

- **The Gombe Formation:** The Gombe sandstones consists of alternating thin beds of silty shale and fine to medium grained sandstone with some intercalated thin flaggy ironstones and some poor quality coal. The formation ranges in age form upper Santonian to Maastrichtian and is about 300meters thick (Zaborski et al, 1997).
- **The Kerri-Kerri Formation:** The Kerri-Kerri formation overlies the Gombe sandstone and it is Paleocene in age (Adegoke et al, 1978). The Kerri-Kerri formation is characterized by fine to coarse sands interbeds of sandy gravels, siltstones and clays (Dike, 1993).
- **The Yola Arm:** The Yola arm is the E-W trending portion of the basin and comprises the continental Bima sandstone, Yolde formation, the Dukul, Jessu, Sekuliye, Numanha shale and Lamja sandstone formation in an upward succession. This is the stratigraphy of the main arm (SW-NE) forming Muri-Lau Basin.

2.2 HYDROGEOLOGY OF GOMBE STATE

The Benue and Gongola have perennial surface flow and their importance as a source of water is reflected by the concentration of population near their banks. Settlements along the Benue, especially to the west of Lau, is restricted by the shortage of suitable village sites owing to seasonal flooding.

In Gombe state, ponds have been excavated on the waterless plain near Wawa and these now provide the water supply for a number of new settlements. The loss of water through evaporation is high; in the northern part of the area it is estimated at 6ft per year and exposed bodies' water.

Ground water in crystalline rock is confined to pockets and patches of weathered rock where well usually encounter water at shallow depths but yields are often small and subject to marked seasonal fluctuations. Ground water has been obtained from the basement in the weathered zone and occasionally also form Joint systems and fracture in fresh rocks. A lot of complexities due to the tectonism that affected the area, there is tendency to have differences in possibility of getting water even with close range of distances.

In the sedimentary formations, apart from the Yolde and Gongila formation and the Gombe formation, the Cretaceous rocks are disappointing as sources of ground water. The Bima formation which consist chiefly of sandstones, forms a comparatively poor groundwater reservoir. Well yield in this formation are often small, owing to low permeability of these sediments which may contain much interstitial clay. High yields can usually be obtained form wells in the Kerri-Kerri formation where the water table is shallow. Unfortunately in many part of the outcrops the water lies at too great depth to be reached by open wells. This is the case in the waterless country between Gombe and Wawa.

2.3 PREVIOUS WORK

The earlier geological work done in the area was by Falconer (1911), as part of the mineral survey of Northern Nigeria. The recognized by presence of sediments of Cretaceous and Eocene ages-the Yolde, Pindiga and Gombe sandstone. They also described the area part of the Nigeria Basement Complex comprising gneisses and migmatites (Precambrian-lower Paleozoic), which were intruded in various places by a relatively younger suite of rocks, the Older Granite.

Carter, Barber and Tait (1963) summarized the geology of the area as consisting of crystalline basement represented mainly by granite rocks, overlain by sedimentary and volcanic rocks ranging in age from upper Cretaceous to Quaternary. Barber et al, (1957) differentiated the Bima sandstone; which they called the Bima grits. According to Carter et al, (1963) the Bima formation consists of coarse grained thick bedded feldspathic sandstone with intercalation of thin bands of siltstone and mudstone. The formation attains maximum development in the Lamurde anticline. The sediments were deposited in a fluvial and deltaic environment in Albian to Cenomanian time.

2.4 GEOLOGY OF THE STUDY AREA

The study area (Kaltungo town) lies within the upper Benue trough of Nigeria which is characterized by major rock types. Generally the area consists of older granites and basically overlain by the Bima formation. The Older Granite constitute the inlier since the area is within a sedimentary basin and consist mainly of the Bima sandstone. The Older Granite are scattered all over the area and believed to have been emplaced during pan African orogeny (Rahaman 1976 and Van Bruman et al 1977) and formed the inliers. The sedimentary rocks consist of Bima formation which comprise largely of non marine sediments that rest with marked unconformity on the Basement Complex (Fig 2).

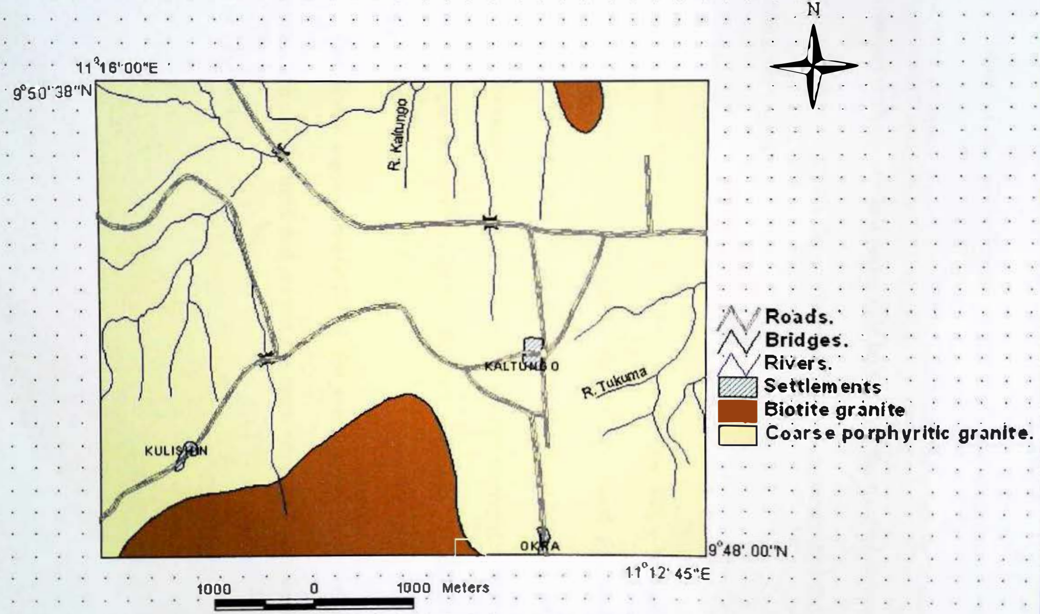


Fig.2: Geological map of the study area

2.5 HYDROGEOLOGY OF THE STUDY AREA

Most of the groundwater in the Kaltungo area occurs either from basement complex within weathered and fractured zones or in sedimentary formation with porous and permeable layers with the mineral composition of the water depending on the environment where it occurs and the element forming the rocks.

The groundwater in the area is mainly underlain by crystalline rocks of the basement complex and it is drained by one major river, the river Kaltungo. Water supply to Willi Village is by hand dug wells, this settlement is located on the Bima formation. The Bima formation is known to provide considerable unconfined ground water reservoir. Water bearing formations are medium to coarse grained sandstones at depth of 20-60meters.

The water supply potentials of the area can be improved if more boreholes are sited within and around the town were favorable water yield can be obtained.

CHAPTER THREE

3.0 METHODOLOGY

The field work lasted for three days comprising basically of two distinct parts. These consist of rock sampling within the area of study, groundwater sampling from hand-dug wells and boreholes (Fig 3 map showing the sampling points).

This was done in attempt to assess fluoride content present in the area, which is the basis of the discoloured, blackened, mottled or chalky teeth coloration.

The methods used in carrying out this study can be grouped into two these are:

1. Sample collection
2. Sample analysis

3.1 WATER SAMPLE COLLECTION

A total of ten (10) water samples were collected, 7 from hand -dug well and 3 from boreholes. Samples were collected by means of plastic containers, which will not react with the water. The containers had previously been cleaned with detergent and rinsed with distilled water before drying. When collecting the water samples form the hand-dug wells a rubber

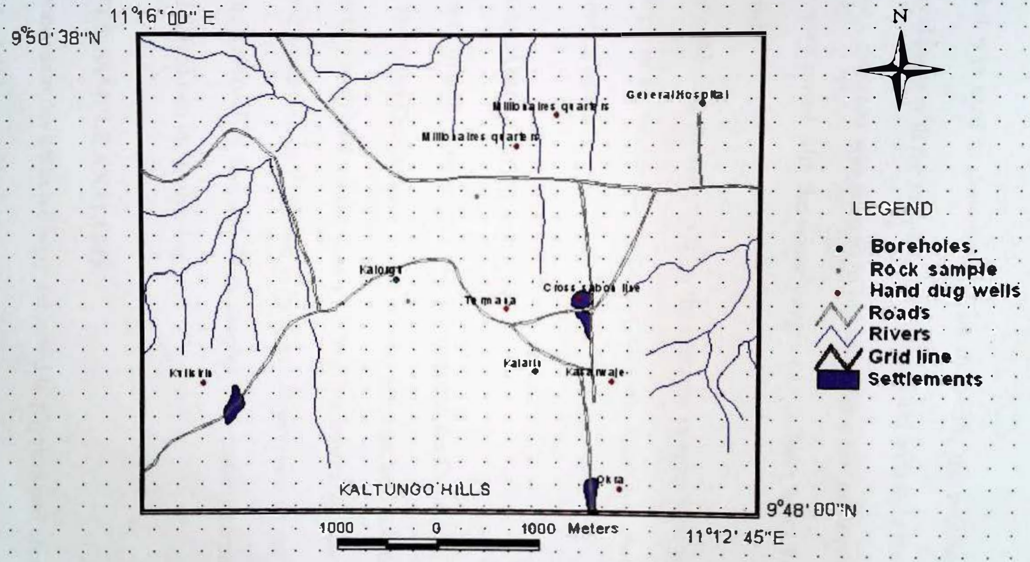


Fig 3. Map of Kaltungo and environs showing sampling points.

bucket was used to draw water from the wells, the containers was rinsed several times with the sample before being filled with it. In the case of the boreholes, the water was allowed to run waste for a few minutes and the containers were rinsed with the water sample two or three times before it was collected.

After collecting the samples from the sites, the samples were taken to the laboratory in an airtight container, for analysis. Plate 1-4 shows the various sampling points.

3.2 ROCK SAMPLE COLLECTION

The area of study consists of Older Granites and the Cretaceous Bima sandstone. The Older Granite suite occurs as inlier since the area is known to be a sedimentary basin and consist mostly of the Bima sandstone. The study was restricted to surface geology that is by direct observation on the field. The area was traversed by foot and fresh samples were collected from one location and placed into the sample bag.

3.3 WATER SAMPLE ANALYSIS

The water samples collected were subjected to physical and chemical analysis in the laboratory. Nine parameters were analysed; three physical and six chemical parameters. This was done is assertion, the concentration of

Plate 1: Shows water sampling medium from Kulishin well

(Location 7)

Plate 2: Shows water sampling medium from Kalorgu borehole

(Location 6)

Plate 3: Shows water sample collection from Termana well

(Location 5)

Plate 4: Shows water sample collection from Kalorgu borehole

(Location 6)

fluoride (F^-) together with other elements such as; calcium (Ca^{2+}), copper (Cu^{2+}), sulphate (So_4^{2-}), Iron Fe (T) and Nitrate (No_3^-). The physical parameter analysed were Temperature, potential hydrogen (pH) and Total Disolved Solids (TDS).

3.4 ROCK SAMPLE ANALYSIS

The rock sample collected were analysed in the laboratory to determine the concentration in mg/l of fluoride (F^-) and calcium (Ca^{2+}). The compositions of the rock were established on the basis of several hand specimen studies and thin section analysis.

3.5 INSTRUMENTATION

The instruments used during the water quality test and rock sample analysis were:

i. TDS/Conductivity meter (HACH) model 44600-00

ii. Titrimetry-Digital Titrator (HACH) model 16-99-01

iii. Spectrophotometer (HACH) model DR/2000

iv. HANNA Instruments pH meter, model HI 28129.

The above mentioned instruments are United State Environmental Protection Agency (USEPA) approved standard method for analysis of water, rock, soil and waste.

3.5.1 TDS/CONDUSTIVITY METER (HACH) MODEL 44600-00

The TDS/conductivity meter was used to measure temperature and Total Disolved Solids (TDS). The instrument consist of the following component a digital display serene, a probe, a read/enter button and a switch. A blind sample with zero water conductivity/TDS was used to calibrate the instrument. After calibration, a sample of 25ml was put to lest by dipping the probe attached to the conductivity meter into the sample. The Read/enter button was pressed to display the values of temperature (°C) and Total Dissolved Solids in (mg/l). Plate 5 shows a TDS/conductivity meter (HACH) model 44600-00.

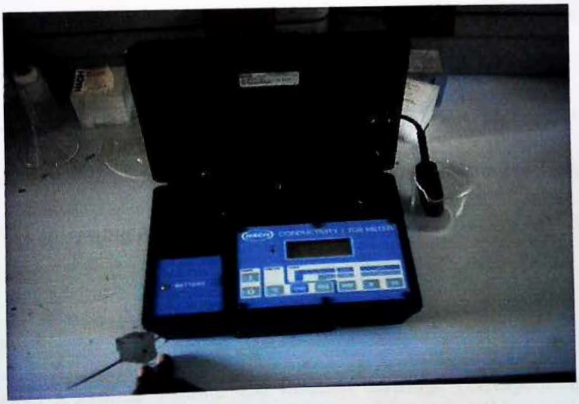


Plate 5: TDS/Conductivity meter (HACH) model 44600-00

3.5.2 TITRIMETRY-DIGITAL TITRATOR (HACH) MODEL 16-99-01

Hach's digital titrator (plate 6) is a new concept in titrimetric analysis. It is a precision dispensing device fitted with concentrated titrants on compact containers called cartridges. Each cartridge consists of a standard titrant. Accurate titrations are made without the bulk and fragility of conventional burettes. A main drive screw in the digital titrator controls a plunger which forces the solution from a titration cartridge in a carefully regulated flow. The titrator body is constructed of precision-molded, heavy-duty chemical and impact-resistant acetal plastic. Accuracy is rated at ± 1% or better for a titration more than digits. For titration less than 100 digits the accuracy is ± 1 digit. Each cartridge contains approximately 13ml of titrating solutions, sufficient for 0-100 average titration. Most titrations are controlled t0 ± 0.5% normalities with normality and tolerances listed on the label. The following are the steps used to carry out a titrimetry analysis.

STEPS

1. Select a sample volume and titration cartridge corresponding to the expected sample concentration from the table in each procedure.

2. Remove the polyethylene cap and insert a clean delivery tube into the end of the cartridge

3. For stationary titration, use a titra stir or a clamp holder and clamp to attach the titrator to a laboratory stand.

4. Slide the cartridge into the titrator receptacle and look in position with a slight turn

5. To start titrant flowing and flushing, the delivery tube, hold the trip of the cartridge up turn the delivery knob until air is expelled and several drops of solution flow from the trip. As you turn the knob, a drive screw pushes a piston against the cartridge seal and force liquid out through the delivery tube. The use the counter reset knob to turn the digital counter back to zero and wipe the tip. The tip can be rinsed with deionized water rather than wiped if desired.

6. Use a graduated cylinder or pipette to measure the sample volume from the given table. Transfer the sample into a 125 or 250ml flask. Dilute the approximate volume with deionized water if necessary.

7. Add indicator to sample and swirl to mix

8. Immerse the delivery tube in the solution and swirl the flask while titrating. Titrate by turning the delivery knob. Keep turning the knob

and swirling the sample until the end point is reached. Record the number of digits that appears in the digital counter window.

9. Calculate the concentration of your sample by using the following formula

Digit required x digit multiplier = sample concentration

Where: Digit required = the number that appeared in the digital counter window

Digit multiplier = the number from in the table given in the procedure. It takes into account the sample dilution and titrant strength

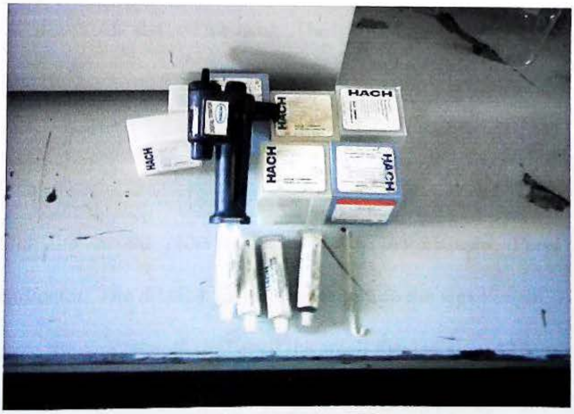


Plate 6. A digital titrator (HACH) model 16-19-01

3.5.3 SPECTROPHOTOMET R (HACH) MODEL DR/2000

Spectrophotometer is an instrument is an instrument that measures transmission or apparent reflectance of visible light as a function of wavelength, permitting accurate analysis of colours or accurate comparison of luminous intensities of two sources or specific wavelengths. Spectrophotometing is a procedure which measures photometrically the wavelength range of radiant energy absorbed by a sample under analysis; it can be by visible light, ultraviolet light, or x-rays. The instrument (spectrophotometer) was first to zero. The wavelength for each parameter to be analysed is available on a manual. all that was needed is to punch the required digits on the enticement. The procedures (steps) carried out to determine the concentration of the elements in sample are:

STEPS

1. Enter the stored program number for the element. Press 2, 9, 5 Read/enter. The display will show dial nm to the wavelength.
2. Rotate the wavelength dial until the small display slow 525nm.
3. Press read/enter to show mg/l of the element to be analysed.
4. Fill a cell with 25ml of sample.

5. If we are analyzing for fluoride we add to the content a spadns powder reagent and swirl to mix.
6. Place the sample in the spectrophotometer.
7. Press shift timer and allow it for some few minutes.
8. When the timer beeps the display will show the concentration of fluoride in mg/l. fill another cell (the blank) with 25ml of sample. Place it into the cell holder close the light shield.
9. Press zero-the display will show wait than 0.0mg/l fluoride .
10. Within eight minutes after the timer beeps, place the prepared sample into the cell holder. Close the light shield.
11. Press read/enter the display will show WAIT then the result in mg/l for fluoride will be displayed on the screen. Plate 7 show a HACH DR/2000 SPECTROPHOTOMETER.

Plate 7: A spectrophotometer (HACH) model DR/2000

3.5.4 HANNA INSTRUMENTS pH METER MODEL HI 28129

A pH meter is an electronic voltmeter using a pH responsive electrode that gives a direct conversion of voltage differences to differences of pH at the temperature of measurement. pH measurement is the determination of the hydrogen-ion concentration in an ionized solution (such as phenolphthalein) or a pH meter. An instrument for the measurement of pH in terms of the potential of an electrolytic pH sensitive cell chain is called a pH meter. The HANNA instrunnent pH meter measures pH (potential hydrogen), EC (electrical conductivity) and TDS (Total Dissolved Solids). This instrument has a glass electrode of thin walled glass bulb. When this bulb is immersed in a solution, a difference of potential which changes linearly with pH appears between the inner and outer surfaces. The instrument is calibrated using a buffer reagent at pH of 7.01. Take 25ml of sample in a container, select the parameter to be analysed and dip the probe into the sample and press your button. A reading will be displayed on the screen showing the pH of the sample. Plate 8 shows a HANNA instrument pH meter.

Plate 8: A HANNA instrument. pH meter, model HI 28129.

3.6 ANALYSIS OF PHYSICAL PARAMETERS

The physical parameters analysis involved determination of physical qualities of water visible to the nacked eyes and easily detectable by the senses. A lot about the quality of water could be predicted from the physical properties exhibited by it.

The following physical parameters were determined using the USEPA approved standard method for analysis of water:

1. Temperature
2. Potential Hydrogen (pH)
3. Total Dissolved Solids (TDS)

3.6.1 TEMPERATURE/TOTAL DISOLVED SOLIDS (TDS)

Temperature of water is a very important parameter in water analysis. Most of the properties (physical and chemical) depend on temperature of the water. Hence it is very essential that temperature of the water is taken at the time of sampling and analysis

Total Dissolved Solids (TDS) refers to the amount of dissolved substances in water, which can be recovered after completely evaporating the water.

The temperature/Total Dissolved Solids (TDS) was determined using conductivity/TDS meter. The apparatus was switched on, then a blind sample (water with zero conductivity/TDS) was used to zero the conductivity/TDS meter after which the sample in the cell was put into test by dipping a probe attached to the conductivity/TDS meter into the sample and then press read/enter button after which the meter displayed the value in form of digits, depending on the parameter. On pressing the button, the values for temperature (°C) and Total Dissolved Solids TDS in mg/l were displayed. This was done to determine the presence of "free electrons" within the body of a sample and also the measure the effect of current flow in a solution.

3.6.2 POTENTIAL HYDROGEN (pH)

This is the value of hydrogen ion concentration (H^+) and it influences other chemical factors especially flocculation. According to the theory of electrical dissolution, all liquids of which water is a constituent contain free hydrogen ion (H^+) and hydroxyl ion (OH^-), where the ions are equal, the liquids is said to be neutral (pH=7), but when (H^+) is higher than (OH^-) it is said to be acidic, and when (OH^-) is higher than (H^+) it is said to be alkaline (pH>7).

The pH for the sample was determined in the laboratory by using a HANNA instrument pH meter. pH is important to this study because it tails us whether the sample contain excess hydroxide ion (OH^-) or excess hydrogen ion (H^+). Also the acidity and alkalinity are determined form the pH.

3.7 ANALYSIS OF CHEMICAL PARAMETERS

The chemical analysis involves the determination of chemical quality of drinking water. Any water whose level of chemical contaminant either by organic or inorganic substances becomes higher than normal, the water is considered to be unhealthy for consumption, domestic, agricultural as well as industrial uses. This is due to the fact that the water has become toxic and can cause a lot of problems, and when such things are encountered, it is advisable to find out the possible solution to pollution rather than condemning the raw water source.

The following chemical parameters were determined using the USEPA approved standard method for analysis of water:

1. Calcium (Ca^{2+})
2. Fluoride (F^-)
3. Sulphate (SO^{2-}_4)
4. Nitrate (NO_3^-)
5. Copper (Cu^{2+})
6. Total ion (Fe (T))

3.7.1 DETERMINATION OF Ca^{2+} CONCENTRATION

The analysis was conducted by using a digital titrator 50ml of sample was collected in a measuring cylinder; lml of buffer solution was pipetted and added to the 50ml sample. Manver 2 Reagent was added to the solution sample. The colour of the solution then turns to red, it was then titrated with Ethylene Di-amino tetra Acetic Acid (EDTA) till the colour change from red to pure blue. The number of digit required was recorded from the digital titrator. The concentration of Ca^{2+} was calculated as follows:

Digit required x digit multiplier = mg/l total hardness as $CaCo_3$

Mg/l Ca=mg/l total hardness as $CaCo_3$ x 0.4.

3.7.2 DETERMINATION OF F^- CONCENTRATION

25ML of the sample was collected and Spadns powder reagent was added to the sample. It was then placed in the spectrophotometer. After the spectrophotometer was programmed for the analysis of fluoride, the concentration was displayed on the screen.

3.7.3 DETERMINATION OF SO_4^{2-} CONCENTRATION

Sulfa Ver 4 powder pillow reagent was added to 25ml of the sample and then swirl to dissolve for 20 seconds. It was left for 5 minutes for the reaction to take place, it was then transferred into spectrophotometer and the result was displayed. The water changed colour to milky white

3.7.4 DETERMINATION OF NO_3^- CONCENTRAITON

25ml of sample was collected in the sample cell and a content of Nitraver 5 Nitrate reagent was added and shook thoroughly and left for fifteen minutes for the reaction to take place. It was then placed inside the

Digit required x digit multiplier = mg/l total hardness as $CaCo_3$

Mg/l Ca=mg/l total hardness as $CaCo_3$ x 0.4.

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3.7.4 DETERMINATION OF NO_3^- CONCENTRAITON

25ml of sample was collected in the sample cell and a content of Nitraver 5 Nitrate reagent was added and shook thoroughly and left for fifteen minutes for the reaction to take place. It was then placed inside the apparatus, the timer was then pressed when the time beeps it displayed the result of Nitrogen. Multiplying the result by 4, 6 and 2 it gives mg/l No_3^-

3.7.5 DETERMINATION OF Cu^{2+} CONCENTRATION

25ml of sample was taken at a time and bicinchominate powder pillow reagent was added to it and then left for 2 minutes of reaction before being transferred into spectrophotometer. The concentration of Cu^{2+} was displayed on the screen.

3.7.6 DETERMINATION OF Fe (T) CONCENTRATION

This was carried out by the use of DR/2000 spectrophotometer. 25ml of the sample was collected in the sample cell and content of Ferrover iron reagent powder pillow was added, shooked thoroughly and left for 3 minutes for the reaction takes place. The sample cell was then kept inside the apparatus and the shifter timer pressed, when the timer beeps it displayed mg/l to Fe (T).

CHAPTER FOUR

4.0 RESULTS AND INTERPRETATION

The result of the physical and chemical parameters for both the water samples and rock sample were evaluated and interpreted and these results were compared with some standards shown in table 2. The mineralogy of the rock sample was established based on handspecimen studies and thin section analysis. Plate (9 and 10) shows the thin section slides.

4.1 PETROGRAPHIC RESULTS

4.1.1 KALTUNGO INLIER

The study area Kaltungo town generally consists of Older Granites all over the area and was believed to have been emplaced during Pan African orogeny (Rahman, 1988) and formed the inlier since the area is known as a sedimentary basin consisting mainly of the Bima-Sandstone. The petrographic variety of the Older Granite analysed is Biotite granite collected from Kaltungo hill in Kalorgu Village (location 6). The study area also consists of the coarse porphyritic granite which was dominant in the area covered by the map.

4.1.2 BIOTITE GRANITE : PETROLOGY

4.1.2.1 HAND SPECIMEN DESCRIPTION OF THE ROCK SAMPLES

In hand specimen, the rock exhibits a porphyritic texture with a dark mineral possible biotite. It also consist of a pinkish mineral likely feldspar and some colourless minerals possibly quartz.

4.1.2.2 THIN SECTION DESCRIPTION OF SLIDE

The thin section study reveals that the rock contains about 30% biotite, tabular in form with high relief and strongly pleochroic. In some part of the slide under Cross Polarized Light (XPL), the dark green mineral shows an initial stage in the alteration of biotite. The green mineral likely chlorite is intergrowing with the biotite (brown in colour). The feldspar present is orthoclase feldspar and they make up to about 45% of the slide. The orthoclase grains are anhedral and are colourless to cloudy under Plane Polarized Light (PPL). The chlorite minerals amount to about 20% of the slide shown on (plate 9 and 10).

The chemical composition of the mineral present in the rock sample is as follows:

- Biotite $K(Mg,Fe)_3AlSi_3O_{10}(OH,F)_2$

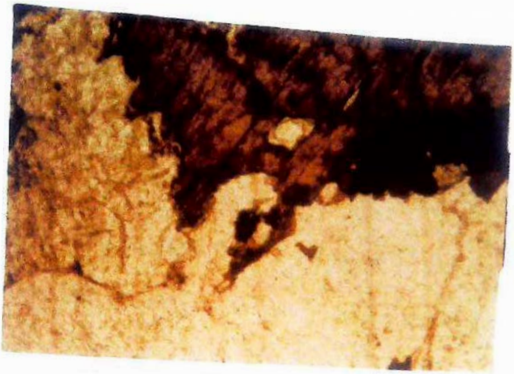


Plate 9: Phenocryst of Orthoclase in Biotite Granite

(Under PPL)

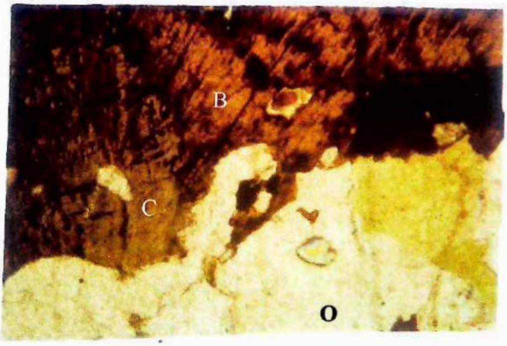


Plate 10: Biotite, Orthoclase and Chlorite in Biotite Granite

(Under XPL)

- Orthoclase $K_2O\ .Al_2\ O_3 .\ 6SiO_2$
- Chlorite $(Mg,Fe,\ Al)_{12}\ (Si,\ Al)_8\ O_{20}\ (OH)_{16}$

Based on the chemical composition of biotite, it shows that 2 molecules of fluoride is present with is our primary aim. Iron is also present in both Biotite and chlorite.

Report from the analysis (Table 3) concluded on the rock sample for fluoride and calcium shows that fluoride was not detected which were suppose to have a crustal abundance of 600ppm and 33000ppm respectively (Green 1959, Taylor, 1964 and Wedepohl 1969-1978) in granite and mafic rocks. The analysis for calcium yielded a result of about 63.64mg/l (ppm) which was far below the background value. The absence of fluoride in the rock sample might be due to the partial digestion of the powdered granite sample with distilled water or the abnormal concentration of the fluoride from water in Kaltungo town has no trace from Kaltungo hills.

4.2 WATER ANALYSIS RESULT

4.2.1 PHYSICAL PARAMETERS

Temperature

The measured temperature of the investigated water samples varied 28.6°C and 29.[illegible]°C. The temperature value exceeds the WHO standard of

25°C. Though sampling was done around 7am-12noon, but yet the temperature remains high. This high temperature (°C) value might have an effect on the TDS (Total Dissolved Solids). Which are quite below the permissible limit defined by WHO and NAFDAC standards. Also temperature has an impact on the solutions, if temperature becomes high it will cause a high mobility of ions within a solution and also speeds up the chemical reaction as a catalyst.

pH (Potential Hydrogen)

The measured pH of the sample varied between 7.38-11.44. The values for 9 sample falls within the WHO standard while 1 sample location 8 exceeds. When the pH of the solution is less than 7 the liquid is said to be acidic and concentration of this can influence a chemical factor known as flocculation (a method for treating water supplies to remove excess fluoride in water). This process is best carried out under alkaline condition, lime is added, bleaching powder can also be added to disinfect the water. In this study, samples with low pH were characterized by high conductivity and vice versa.

Total Dissolved Solids (TDS)

Total Dissolved Solids includes all solids materials in solution whether ionized or not, it does not include suspended material or dissolved gas. Higher TDS in any water sample gives a greater level of pollution. The TDS values for all the water samples are below the maximum permissible level. Thus all the water samples satisfy the World Health Organization WHO) recommendation for drinking (Table 2). From the values obtained during the analysis it shows that pollution rate is minimal in the area because the values are lower than the maximum permissible level.

Table: 2

The guidelines on drinking water by World Health Organization (WHO), National Agency for Food and Drug Administration and Control (NAFDAC NIGERIA) and National Primary Drinking Water Regulation (NPDWR, US) is show in Table 2.

TABLE2. COMPARATIVE STANDARDS FOR DRINKING WATER

No	TEST PARAMETERS	MAXIMUM ACCEPTABLE CONCENTRATION (WHO)	MAXIMUM ALLOWABLE CONCENTRATION (NAFDAC)	MAXIMUM CONTAMINATED LEVEL (NPDWR,US)
	pH range	7.0-8.5	6.5-8.5	6.5-8.5
	Total Dissolved Solid(TDS)Mg/L	1000	500	500
	Temperature(^{0}c)	25	–	–
	Calcium,Ca2+ Mg/L	75	75	50
	Copper,Cu2+ Mg/L	2.0	–	1.3
	Iron,Fe(T) Mg/L	0.05-0.3	–	Not exceeding 0.3
7	Floride,F- Mg/L	1.5	–	1.3
8	Sulphate,SO42- Mg/L	200	200	–
9	Nitrate, NO3- Mg/L	50	–	10

Source: (WHO, NAFDAC AND NPDWR US)

Table 3: Results of Water and Rock Analysis

PARAMETERS	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	RS	NAFDAC & W.H.O STANDARDS
Temperature, oC	28.80	28.80	28.70	28.80	28.60	28.70	28.90	28.90	29.00	29.00	28.90	25
pH	7.71	7.98	7.75	7.38	7.49	7.54	7.50	11.44	7.95	8.08	8.67	6.5 – 3.5
Total dissolved solid, (TDS) mg/l	346	316	80	122	223	144.5	176	400.5	261.5	264	105.5	500
Calcium, Ca^{2+} mg/l	70.20	111.7	20.64	40.56	74.84	62.60	58.45	101.7	75.24	47.24	63.64	75
Copper, Cu^{2+} mg/l	0.34	0.36	0.1	0.35	0.1	0.23	0.96	0.48	1.03	1.57	-	1.0
Iron, Fe (T) mg/l	3.17	2.70	4.04	2.88	3.02	4.68	3.21	2.63	2.60	2.61	-	0.3
Fluoride, F^- mg/l	1.62	N.D	1.60	1.36	1.24	1.50	0.64	0.94	1.10	1.26	N.D	1.5
Sulphate, SO_4^{2-} mg/l	27	34	7	ND	22	9	24	10	34	32	-	250
Nitrate, NO_3^- mg/l	53.4	98.0	120.4	46.8	121.2	90.4	108.6	164.04	113.04	96.8	-	45

KEY

ND = Not Detected

able 4: Sample numbers, location name and source

ample Number	Location Name	Source
S1	Cross, Sabon Line	Hand Dug well
S2	Kasar Waje	Hand Dug well
S3	Okra	Hand Dug well
S4	Kalarin	Borehole (Hand pump)
S5	Termana	Hand Dug well
S6	Kalorgu	Borehole (Hand pump)
S7	Kulishin	Hand Dug well
S8	Millionaires Quarters A	Hand Dug well
S9	Millionaires Quarters B	Hand Dug well
S10	General Hospital	Borehole(hand dump)
RS (Rock Sample)	Kalorgu	Kaltungo Hill

4.3 CHEMICAL PARAMETERS

The chemical parameters were analysed to determine the concentration of the various elements in the water sample. These elements are divided in the following:

a. Cations (positive ions)

b. Anion (Negative ions)

4.3.1 CATIONS

The cations analysed are: Ca^{2+}, Cu^{2+}, and Fe^{2+}(T)

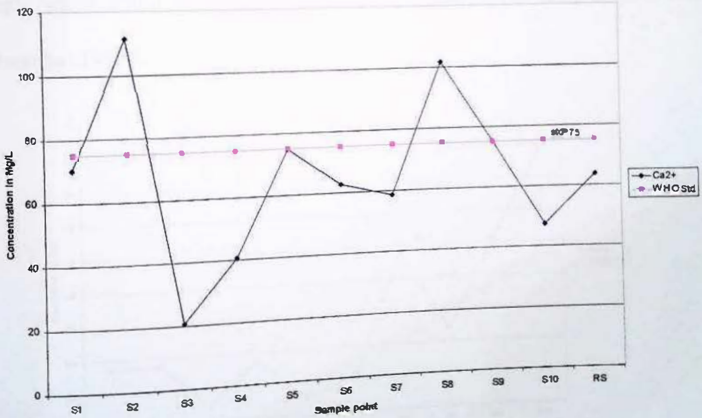


Figure 4: Concentration of Ca^{2+} in sample medium

Calcium dissolved in water is one of the most common sources of water hardness content increases. Hard water interferes with almost every cleaning task from dish washing and laundering to bathing and other personal uses. Hard water has no health effect but rather it contributes to human dietary needs.

The Ca^{2+} values for sample number (2 and 8) are above the permissible value set out by the WHO and NAFDAC standard, the values stands out as anomalies, sample number (5 and 9) stands out as background value while sample (1,3,4,6,7 and 10) represent the threshold values. The locations with high concentration are within residential areas and it shows no effect on the people leaving there. In areas where dissolved calcium is very high, water could be a major contributor of calcium to diet, Evanko and Dzombak1997).

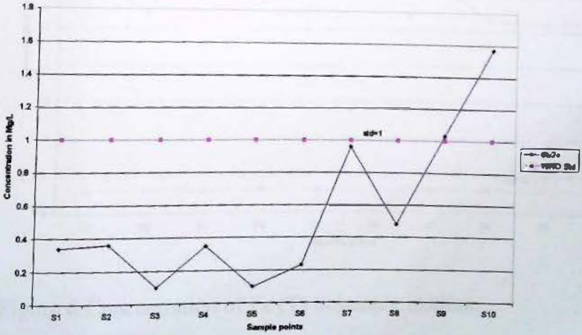


Figure 5: Concentration of Cu^{2+} in sample medium

Copper is a trace element, and depending on its concentration in rinking water as well as pH of water, it is regard as toxic (Seim and ischen dorf, 1990). Copper concentration is higher than the permissible imit in millionaires Quarters (B) and General hospital (location 9 and 10) with anomalous values of 1.03 mg/l and 1.57mg/l respectively. This is probably due to the corrosion of interior plumbing. All other value was below the permissible limit indicating a low level of toxication. A number of studies in the United State indicate that copper level in drinking water samples can range from 0.005 to 18mg/l (ATSDR, 1990; USEPA 1991).

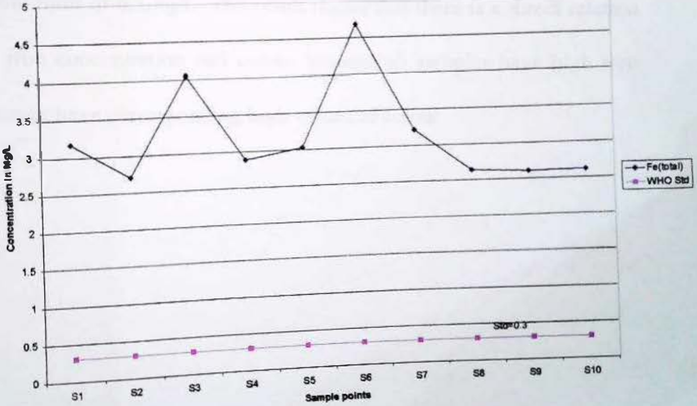


Figure 6:Concentration of Fe (T) in sample medium

Iron is a common metallic element found in the earth crust. Water percolating through soil and rock can dissolve minerals containing iron and hold them in solution. Occasionally, iron pipes also may be source of iron water. Oxidation of dissolved iron particles in water changes the iron to white, then yellow and finally to red-brown solid particles that settles out of the water. A problem that frequently results from iron in water is iron bacteria. These non pathogenic (non health treating) bacteria occurs in soil, shallow aquifers and some surface waters (Aamir and Tahir, 2003). In the study area, all the measured values for Fe^{2+} are above the WHO maximum permissible limit of 0.3mg/l. The result shows that there is a direct relation between iron concentration and colour because all samples have high iron concentration have corresponding high values of colour.

4.3.2 ANION

The anions analysed are F^- , SO4 and NO^-_3.

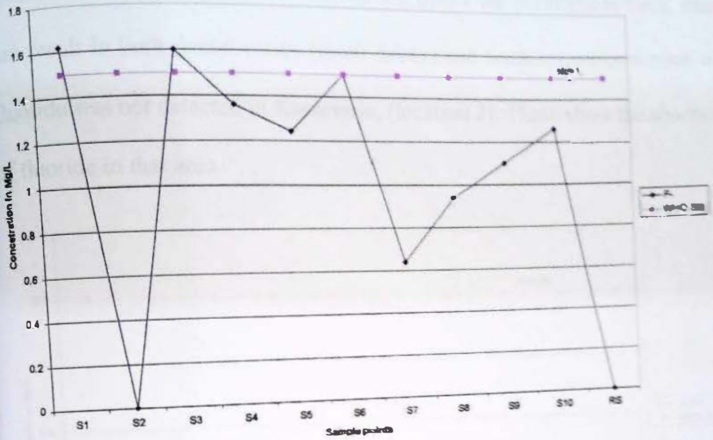


Figure 7: Concentration of F- in sample medium

Thus a case of fluoride concentration is of more interest in the study because it forms one of the most notable abnormalities present in the area Fluoride is considered to be an essential element, although dental health problem may arise from excess fluoride, hence high concentration of fluoride in drinking water is harmful (WHO, 1996). In the study area fluoride concentration is below the value recommended by WHO. Fluoride concentration is higher than the permissible limit in Cross-Saboo line and Okra village (location 1 and 3) with anomalous values of 1.62mg/l and 1.60mg/l respectively. This indicates that the fluoride content present in ater in these locations is high, which can cause dental flourosis. At location (Kalorgu) the value is equal to the NAFDAC and WHO standard. In cation (4, 5,7,8,9 and 10) the values are below the pennissible limit, thus in result in both dental caries (tooth decay) and fractures concentration of uoride was not detected in Kasarwaje, (location 2). These show the absence f fluoride in that area.

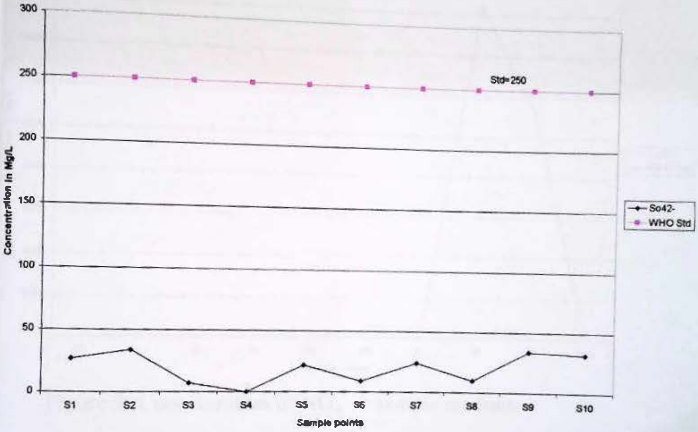


Figure 8: Concentration of SO_4^{2-} in sample medium

Sulphates are a combination of sulphur and oxygen and are part of naturally occurring minerals in some soil and rock formations that contain groundwater. The mineral dissolves overtime and is released into groundwater. Sulphate may have a laxative effect that can lead to dehydration and is of special concern for infants. With time, people and g livestock will become acclimated to the sulphate and the symptoms pear. Sulphur oxidizing bacteria pose no known human health risk C, 1994). However, sulphate concentration in the study area is low pared to the maximum permissible limit. For location 4 (Kalarin) it was detected.

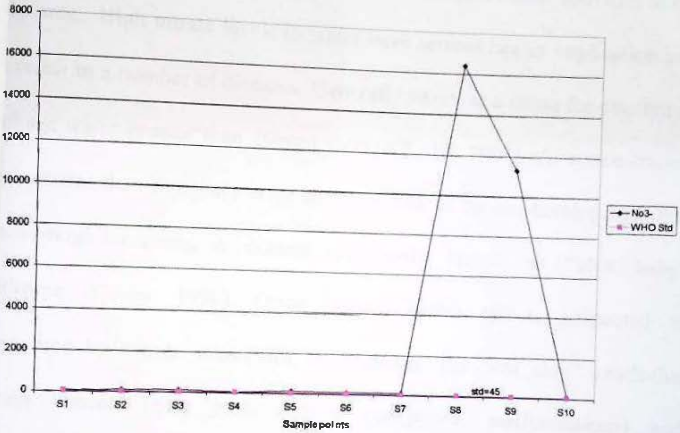


Figure 9: Concentration of NO_3^- in sample medium

The concentration of NO_3^- in the investigated water calls for concern. Vhen compared with the WHO standard value of 45mg/l, all the samples for he 10 location have values greater than the recommended value by WHO, vith location 8 and 9 been highest. Only one value was below the maximum acceptable concentration (WHO). Nitrate is becoming increasingly widespread because of agricultural activities and disposal of sewage on or ıeath the land surface. The direct source of nitrate in ground water ginates as NO_3^- from wastes or commercial fertilizer applied to land face (Adelana and Olasehinde, 2003). Based on the result gotten from analysis, we can conclusively say that the high value of NO_3^- in the study ea (Kaltungo town) could be connected to high agricultural activities in the dy area. High nitrate levels in water have serious health implication and n result in a number of diseases. Generally nitrate is a cause for concern in inking water greater than 10mg/l (NPDWR, US 2001). At concentration vel greater than this there is an increased risk of babies developing infant athaemoglobineamia, a disease commonly known as "blue baby" ndrome (Canter 1996). Other human health effects suspected to ggravated by nitrate intake are hypertension, the "hot clog" headache, ertain cancer, some birth defects (congenital malformations) and pontaneous absorption (Lamb, 1985).

Location 8 and 9 show very high concentration this is because gricultural activities and disposal of sewage is very rapid in the area and lso cattle rearers do take their cattles for grazing. So if they dispose their vaste product and it come in contact with rainwater it percolate into the ubsurface and contaminates the water

CHAPTER FIVE

DISCUSSION, SUMMARY AND CONCLUSION

FLUORIDE GEOCHEMISTRY AND DENTAL HEALTH

The geochemistry of fluorides in groundwater and the dental health of nunities, particularly those depending on groundwater for their drinking lies is one of the best known relationships between geochemistry ent (Wood, 1974) although dental health problems may arise form an ss of fluoride. Many water supply schemes particularly in developing itries where dug wells and deep boreholes form the major water sources, ain excess fluoride and as such are harmful to dental health sanayake, 1991). Countries with endemic fluorosis due to excess ride in drinking water extend form Syria through Jordan, Egypt, Libya, eria, Morocco and the Rift valley of Western Africa through the Sudan Kenya.

Table 5 shows the impact of fluoride and several organizations oughout the world have considered fluoridating water supplies in areas ere the water supplies do not provide the optimum trends of fluoride.

Table 5: Impact of fluoride on health (Source WHO, 1871)

oncentration of oride	Impact on health
il	Limited growth and fertility
0 – 0.5mg/l	Dental caries
5 – 1.5mg/l	Promotes dental health resulting in healthy teeth; Prevents tooth decay
5 – 4.0mg/l	dental fluorosis (mottling of teeth)
0 – 10.0mg/l	Dental fluorosis, skeletal fluorosis (pain in back and neck bone)
10.0mg/l	Crippling fluorosis

The most salient feature of the geochemistry of fluoride is it ability to easy exchange with the OH⁻ ion, which has an ionic radius similar to that of the F⁻ ion. The fluoride-hydroxyl exchange in geological materials has therefore been a subject much studied (Gillberg, 1964; Stormer and Carmichael, 1971). Fluoride in the surface and groundwater are derived from:

a. Leaching of the rocks rich in fluorine, e.g granite 750ppm; alkali rocks 950 ppm; volcanic ash and benttonites 750ppm; phosphatic fertilizer 3.0 – 3.5%

b. Dissolution of fluorides from volcanic gases by percolating groundwater along faults and joints of great depth and discharging as fresh and mineral springs.

Rain water, which many acquire a small amount of fluoride from marine aerosols and continental dust.

Industrial emissions, such as organic fluorine and. dust in cryolilite factories.

Industrial effluents.

Rum-off from farms using phosphoric fertilizers extensively.

FUNCTION OF FLUORIDE

Daily, minerals are added and lost in the tooth's enamel layer through processes known as Remineralization and Demineralization. Fluoride s prevent tooth decay by making the tooth more resistant to acid attacks. so reverses early tooth decay in children under 6 years of age, fluoride omes incorporated into developing permanent teeth, making it difficult acids to demineralise the teeth. Fluoride also help spread remineralisation vell as disrupt acid to acid production in already erupted teeth of both dren and adults. Fluoride is absorbed in stomach and small intestine. e in blood stream. It rapidly enters mineralized tissue. At usual intake els fluoride does not accumulate in soft tissues, the predominantly eral elements in bone are crystal of calcium and phosphate, known as

5.1.3 EFFECTS OF LITTLE AND EXCESS FLUORIDE

Fluoride is a desirable substance. It can prevent or reduce dental decay and strengthen bones, thus preventing bone fractures in older people. Where the fluoride level is naturally low, studies have shown higher levels of both dental caries (tooth decay) and fractures. Due to its positive effect, fluoride is added to water during treatment in some areas with low levels. In the case of fluoride, water levels above 1.5mg/l may have long-term undesirable effects (Table 5). Much depends on whether other sources, such as vegetables, also have high levels. The risk of toxic effect rises with the concentration. It only becomes obvious at much higher level than 1.5mg/l. The natural level can be as high as 95mg/l in some water, such as in Tanzania where the rocks are rich in fluoride containing minerals. Plate 11a, 11b, 12a, 12b, 13a and 13b shows pictures of dental fluorosis.

5.1.4 ANOMALY DUE TO FLUORIDE

Human appears to vary considerably with respect to their susceptibility to fluorosis. As a general guideline, prolonged total fluoride intake exceeding 1.0mg/ day can produce clinical signs of fluorosis in adults. Fluoride status in human is governed by a variety of factors that covers a wide range of medical, Environmental, Economic and Socio-political issues.

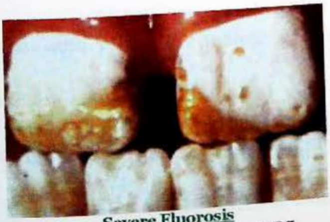
Pictures of Dental Fluorosis

Mild Fluorosis
Photo by Hardy Limeback, DDS
Plate 11a

Mild Fluorosis
Photo by Elke Babiuk
Plate 11a

Moderate/Severe Fluorosis
Photo by David Kennedy, DDS
Plate 12a

Moderate/Severe Fluorosis
Photo by David Kennedy, DDS
Plate 12b



Severe Fluorosis
Photo by John Colquhoun, DDS
Plate 13

Severe Fluorosis
Source of photo unknown
Plate 13b

It is not possible to effectively deal with fluoride within your patient ommunity without understanding all aspect of this problem. In dealing with bnormal concentration of fluoride that is mostly high in water than plant, egetable and other sources in Kaltungo area, it was observed that the dental luorosis in the area is sourced in the water

Dental fluorosis is an irreversible condition caused by excessive ingestion of fluoride during tooth forming years. It is the first visible sign that a child has been over exposed to fluoride. Fluoride cause dental fluorosis by damaging the enamel forming cell called ameboblasts. The damage to the cell results in a mineralization disorder of the teeth, whereby the porosity of the sub-surface enamel increased. While some dental professionals claim that the dental fluorosis is solely a 'Cosmetic' effect, and not a health effect, this statement is an assumption and not a fact. Certainly dental fluorosis represents a toxic effect on tooth cells.

Excessive intake of fluoride can lead to the severe and permanent bone and joint deformation of skeletal fluorosis. This involves abnormal mineralization of bone and soft tissues and/or the disruption of normal activity of the osteocyles. For this reason, skeletal fluorosis often mimics "generic" osteoarthritis and/or osteoporosis in relatively young adults.

Systemic fluorosis is due to chemical nature of fluoride and its action) within mammalian system which is not limited to teeth and bone, fluoride xicity may potentially be linked to every major multiple cause ailment of e 20th century from cancer to alteration Deficit Disorder.

Be it dental, skeletal and systemic, fluorosis is irreversible and no reatment exists. The only remedy is prevention, and by keeping fluoride lefined by the WHO (World Health Organization).

Iron believed to be the tenth most abundant element in the universe, when leached from the bed rocks and enters the water bodies. Iron causes conjunctivitis, choniditis and retinitie, if it contact and remain in the tissue. Chronic inhalation of excessive concentration of iron oxides fumes or dust may result in development of a benign phenumoniosis called siderosis. Excessive concentration of iron oxide may enhance the risk of lung cancer development in workers exposed to pulmonary carcinogens.

5.2 SUMMARY

The physical and chemical analysis of water sample carried out in the study area (Kaltungo town) reveals the knowledge of water quality in the area. Based on the general interpretation of the results, the outcomes are summarized as follows.

Physically, the TDS (Total Dissolved Solids) valves were below the permissible limit. The pH values for samples number (1, 2,3,4,5,6,7,9 10) are within the WHO permissible range of 6.5 – 8.5. The erature values for all the samples analysed were above the permissible of 25°C, this might be probably due the depths of the aquifers, and also d on the facts that temperature increases with depth.

Chemically, from the results of the analysis, it shows that Fe (T) centration in mg/l in the sample medium was higher than the WHO nissible limit. This high concentration can result to a number of disease ed earlier. In the case of Ca^{2+}, only two of the values were above the HO recommended values. All the values for SO_4^{2-} are below the missible value, for F^- and Cu^{2+}, almost all the investigated water samples d their values below WHO standard, except sample (1 and 3) for F^- and mple (9 and 10) for Cu^{2+} which exceeds the WHO permissible limit. The ncentration of NO_3^- in the sample medium was very high. Higher values f nitrate in water sample has a serious health implication, as stated earlier, is was due to increasingly wide spread agricultural activities and disposal f sewage on or beneath the land surface.

The study area is subdivided into two geological units. These include he Pan Africa Older Granite suite and the Bima sandstone. The petrographic iety collected from Kaltungo hill in Kalorgu village (location 6) where highest value for Fe (T) concentration was observed, also a background ue of F^- (fluoride) was observed too.

The thin section studies shows that the minerals present on the slide e Biotite about 30%, orthoclase feldspar to about 45% and chloride ineral amounting to about 20% of the slide. Fluoride concentration in the ck sample could not be detected while for calcium, the concentration was out 63.64mg/l(ppm) which was far below the background value of 3000ppm.

.3 CONCLUSION AND REMEDIES

Poisoning resulting form fluoride can be prevented or minimized by using alternative water sources, by removing excess fluoride form drinking water and by improving the nutritional status of the population at risk. Rain water is usually a cleaner water sources and provides a low cost simple solution. Particular caution is required when opting for surface water, since it is often heavily contaminated with biological and chemical pollutants. Surface water should not be used for drinking without treatment and disinfection.

The problem however is limited storage capacity in communities or ouseholds. Large storage reservoirs are used because annual rainfall is xtremely uneven in tropical and sub tropical regions though such facilities re expensive to build and require large amount of space. Fluoride content an vary greatly in wells in the same area, depending on the geological tructure of the aquifer and the depth at which water is drawn. Deep tube-vells and sinking new wells in another site may solve the problem. The fact hat fluoride is unevenly distributed in ground water, both vertically and orizontally means that every well has to be tested individually for fluoride in areas endemic for fluorosis. Fluoride can also be removed or treated through flocculation and adsorption.

In flocculation, Alum (hydrate aluminium salts) a coagulant commonly used for water treatment is used to flocculate fluoride ions in the water. Since this process is best carried out under alkaline conditions, lime is added, bleaching powder can also be added to disinfect the water. The other approach which is adsorption involves filtering water down through a colum packed with a strong adsorbent, such as activated alumina, activated charcoal or ion exchange resins. This method too is both suitable for community and house hold use. Also based on clinical assessment the risk of tal fluorosis can be reduced by adequate calcium intake and vitamin C y also safe guard against the risk.

RECOMMENDATION

As regards to the results of this study the following recommendations can be made

Water from the wells and boreholes should be subjected to sample treatment method like chlorination, boiling of water before drinking or in the alternative the water should be allowed to settle down before drinking.

- Wells and boreholes should not be sited close to pit latrines, they should be much more farther away from the wells.
- Great caution should be exercised in the selection of a well and borehole site to reduce possibility of contamination from the surroundings and other geological formations
- The boreholes drilled should be cased with PVC (polyvinyl chloride) casing which has resistance to corrosion and rusting. Wells should be lined with concrete during construction and their construction should be properly supervised

Waste disposal site should be located far away from wells and boreholes.

Frequent sanitary surveys of the wells and boreholes should be encouraged by government to locate and identify health hazards which might exist in the wells.

More study should be done in the study area. The studies should include:

a. Different rock successions found in the wells and boreholes.

b. Ground water pollution in the area, and based on the results obtained, the best local treatment methods for the wells and boreholes water should be employed.

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