# Assessment of the environmental impacts of marble quarrying on surface water at Kwakuti, Niger state, North Central Nigeria

**Ako T. A., Onoduku U. S.,Waziri S. H., Adegbe M., Chukwu J. N., Kajena C. M**

*Abstract*— **The determination of the impacts of marble quarrying on the surface water at Kwakuti was determined by assessing the physico-chemical properties of the water samples obtained from Kwakuti and its environs. The concentration of heavy metals, cations concentration, anions concentrations were determined in the laboratory. The values of the physical properties such as pH, electrical conductivity (EC), total dissolved solid (TDS) were immediately measured on the field. The average values for the concentration of heavy metals for the five locations sampled at Kwakuti are as follows; arsenic (As) (>0.01mg/l) which conforms to the World Health Organization (WHO) and Standard Organization of Nigerian (SON) standards of 0.01mg/l, cobalt (Co) was not detected in any of the five locations and zinc (Zn) with an average concentration of 0.30mg/l still lies within the allowable limits of 3.0mg/l proposed by the WHO. These were determined by the use of atomic absorption spectrophotometer (AAS) and as shown by these values, most of the heavy metals are below the maximum allowable concentrations of WHO and SON except for lead ($Pb^{2+}$) which has an average concentration of 0.42mg/l which is higher than the maximum allowable concentration of 0.01mg/l which is higher than the acceptable limits of the WHO and SON. The mean concentration values of the cations are found to be as follows; calcium ($Ca^{2+}$), 46.48mg/l; magnesium ($Mg^{2+}$), 28.12mg/l and these values are higher than the WHO standard of 0.20mg/l. Sodium ( $Na^{2+}$) has a mean value of 3.39mg/l which is an acceptable value compared to the WHO and SON standards of 200mg/l; potassium ($K^+$) has an average concentration of 2.46mg/l and iron ($Fe^{2+}$), 0.01mg/l as opposed to the Nigerian standards of 0.3mg/l. These values are all within acceptable limits except for the concentration of magnesium ($Mg^{2+}$) which is quite higher than those of WHO and SON. The anions are all within the acceptable limits. Sulphate ion ($SO_4^{2-}$) has an average value of 0.0094mg/l compared to the acceptable limits of 250mg/l while the bicarbonate ion ($HCO_3^-$) has an average value of 13.8mg/l. Nitrate ion ($NO_3^-$) has a mean concentration of 5.0mg/l well under the limits of 50mg/l, phosphate ion ($PO_4^{2-}$) has a mean value of 0.025 and chlorite ($Cl^-$) is at 22.33mg/l compared to the acceptable limits of 250mg/l. It was concluded that the major contaminants in the surface water at Kwakuti and its environs are $mg^{2+}$ and $pb^{2+}$. The effects of lead accumulation human health is well known and this has made the surface water in Kwakuti in no way suitable for the drinking either by humans or animals or even for other agricultural purposes such as irrigation due to high concentrations of $Pb^{2+}$ and $Mg^{2+}$ in the water and urgent steps should be taken to provide safe drinking water to the people in Kwakuti area.**

***Index Terms***— **heavy metals, Kwakuti, marble, mean concentration, physico-chemical, safe drinking water.**

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## I. INTRODUCTION

Industrial development is associated with both positive and negative impacts on the environment. The negative impacts cannot be allowed to hinder industrial development but they should be properly mitigated in such a way that these impacts on the environment become insignificant. An example of such industrial development is mining and quarrying of mineral resources. The determination of the impacts of mining activities on environment is a quite an important issue in sustainable development and managements of the available resources. The contradiction between mining activities and protection of the environmental has increased in the recent times, placing more emphasis on the need for improved information on the dynamics of environmental impacts at regional and local scales [1]. Surface mining activities range from large open-cast mines and base metal mines to much smaller aggregate (rock, gravel and sand), industrial minerals (potash, clay) and building materials (granite, stone and marble) quarries. Delineating the activities of mining operations and determining their associated environmental impacts is significantly a difficult problem due to the extensive area that may be affected and the large size of the individual mines that may be involved. Monitoring these changes and controlling them have become more difficult due to the financial implications and the time in producing reliable and up-to-date mapping. Also, an effective monitoring technique for the evaluation of the impacts of mining/quarrying processes and their dynamics needs observations with frequent coverage spanning over a long duration of time so as to make a distinction between the natural changes and those associated with human activities.

The surface drainage patterns are frequently obliterated by quarrying activities and some of the deep open-cast and underground mines draw down water (cognate water) which have been conserved for centuries or even more. The impacts of mineral mining and quarrying on the economy are so priceless that the degradation and loss of water is frequently considered as a small price to pay for the resources. The obvious trends in most environmental assessments of mining/quarrying operations is that mining is one of the greatest contributing factors causing negative impacts on the sources of water and needs a much more greater attention than is presently given to it.

Marble is one of the solid minerals that are present in high abundance in Nigeria [2]). Marble is formed from limestone as a result of heat and pressure in the earth crust thereby causing a change in texture and makeup of the limestone. This process is called re-crystallization. Marble mining is a part of the industrialization process, these industries provides employment for hundreds of people within communities and the nation at large. Nevertheless, as marble mining progresses, the destruction of ecosystem continues, which results in environmental deterioration such as deforestation, pollution of soil, water and air and exposure of the top soil leading to its leaching and erosion. The pollution of surrounding surface and ground water can also result from marble mining. The particulates that are dispersed from the quarries to the surrounding environment can cause an extensive accumulation of Calcium and Magnesium compounds in the soils, sediments, water and vegetations within the area. Mining is one of the significant channels by which the environment is polluted [3]. These activities have a substantial consequence on the air and water, biodiversity reduction, pollution of the soil and land degradation. Mineral exploration directly or indirectly affects flora and fauna composition of the ecosystem and even other non-things through the physical and chemical alteration of the environments [4].

In general, the natural environment is composed of the land/soil, water and air. The release of any industrial wastes into any one of these components or the excessive modification of one of these components of the environment results in pollution and the presence of these pollutants affects the natural balance of the environment which in turn affects the quality of the environment (land, water, air) thus affecting plants, animals and human life. This work intends to study the impact of quarrying marble on surface water resources in Kwakuti using physicochemical properties of the water samples and comparing these values with the acceptable standards in Nigeria and the world.

## II. MATERIALS AND METHODS

The method adopted for this study consisted of field and laboratory work. During the field work, the geology of the area was studied so as to reveal the various lithologies. Dilute Hydrochloric acid (HCl) was used to differentiate the marble from other rock types. Water samples were collected from five locations within the study area. One liter plastic bottle was used for the sample collection, while the samples to be analyzed for physicochemical characteristics were conserved by adding concentrated nitric acid (5 ml to 1litre of the water). The plastic water bottles were filled to the brim and covered tightly to avoid space in the bottle for the collection if oxygen that may cause the oxidation of the metal content in the water. Parameters like pH, temperature, electrical conductivity (EC) were measured on the field. The samples were preserved in a refrigerator and finally taken to a laboratory for analysis. Within the study area, water samples were taken in a random manner. The control sample was taken from the Gada stream which is about 200meters from the Kwakuti village and is labelled point 1. It is taken as the control sample because it is about 2.4 km from the marble quarry location and upstream of it. It is the main drinking water source for the Kwakuti people. The other four samples four water samples were taken seasonal streams close to the quarry site “Fig. 1”. These streams around the quarry are used by other smaller villages and mainly by the illegal miners as their drinking water source and other uses. A total of five samples were taken from Kwakuti.

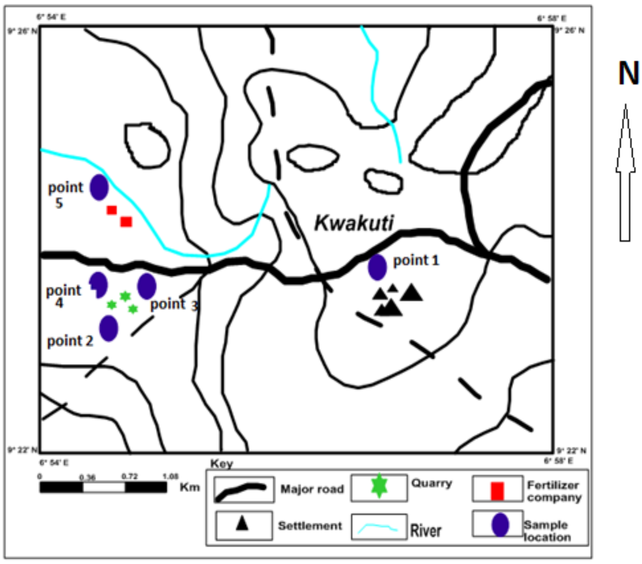



Figure 1: A map of the study area showing the sampling points

Physiochemical parameters such as electrical conductivity (EC), hydrogen ion activity ($p^H$), total dissolved solid (TDS), temperature, calcium ($Ca^{2+}$), magnesium ($Mg^{2+}$), sodium ($Na^+$), potassium ($K^+$), lead ($Pb^{2+}$), cadmium (Cd), iron ($Fe^{2+}$), Zinc ($Zn^{2+}$), Copper ($Cu^{2+}$), Arsenic($As^{3+}$), chloride ($Cl^-$), nitrate ($NO^{3-}$), bicarbonate ($HCO^{3-}$), sulphate ($SO_4^{2-}$), phosphate ( $PO_4^{2-}$ ) and carbonate ($CO^{3-}$) were determined in the laboratory using Atomic Absorption Spectrophotometer (AAS) according to the methods described by described by [5]. The analyses were done in the laboratory of the National Geo-science Research Laboratory (NGRL), of Nigerian Geological Survey Agency (NGSA), Kaduna. The results of the analyses were compared with those of the [6] and [7].

## III. RESULTS AND DISCUSSIONS

### 3.1 Geology of Kwakuti

The study area is characterized by two main rock groups which are rocks of the migmatite-gneiss complex and the meta-sedimentary rocks “Fig. 2”. The Granite gneisses occur as hilly and low lying outcrops and they have contacts with other rocks such as amphibolites. The granitic gneiss is light to dark coloured, and has a medium to coarse grained texture with a very poor gneissic texture with different degree of foliation. The variation in the colour of the rocks depends largely on the type and amount of the feldspars and the ferromagnesian minerals present. Hand specimen of the rocks shows that they contain feldspar, quartz and biotite. Amphibolites, schist, quartzite and marble that comprise the meta-sedimentary rocks occupy the western part of the area and are bordered by North-South trending units of the migmatite-gneiss complex.

The Kwakuti marble is inter-bedded with quartzite and schist in foliated gneiss. Most of the samples contain dolomite (as determined by acid test) and magnesite in addition to calcite with tremolite and antigorite as the main ferromagnesian minerals. The marble also occur as hilly, massive and low-lying outcrops. The deposit is well expressed at the quarry site where the overburden has been removed. Careful observation of the outcrop will show that there is a contact between the marble and amphibolites schist with quartzite and most of the marble samples contain graphite. The marble in Kwakuti has two varieties which can be distinguished based on colour and texture. These are grey and white varieties, the white occur at the flanks of the quarry pits and is coarse grained with interlocking grains of calcite which also extend across the major road. The grey variety at the centre of the pits and is fine grained. Mineralogical examination indicates that both varieties are made up of calcite, dolomite, graphite and little quartz.

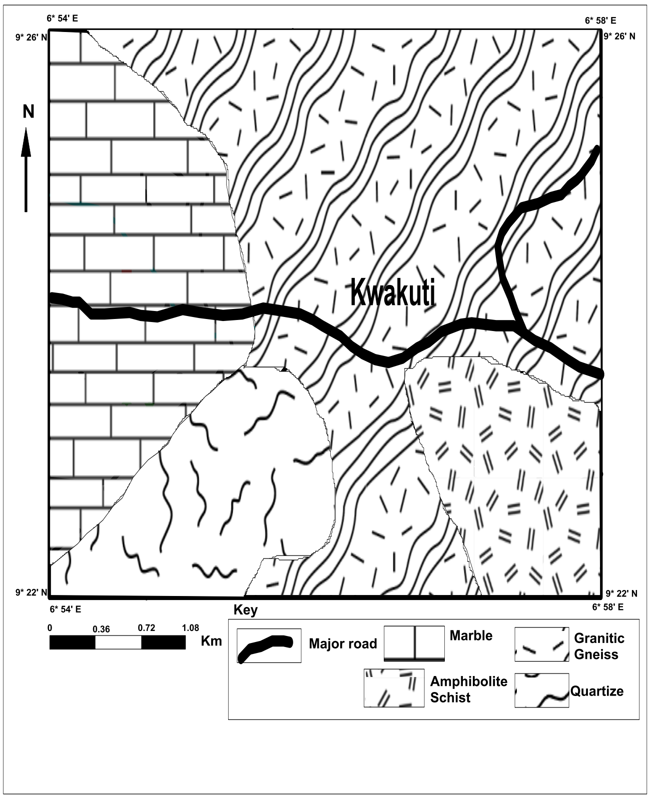



Fig. 2: Geological map of Kwakuti showing the various lithologies observed in the study area

### 3.2 Field observations

During the field work exercise, certain observations were made. The metamorphic rocks seen in outcrops were measured in terms of their strikes and dips and their relationship with other rock types in the area. It was also observed that the mining activities in the area have been reduced to the activities of illegal miners in the area. With their lack of skills and lack of respect for the environment or any government regulation guarding it, they indiscriminately create pits and trenches so as to dig out marble boulders that they can crush and sell. Most of the streams around the quarry sites are used for rice farming, so whatever fraction of soluble contaminants present in the waste heaps or the contaminated water is sure to be taken by the crops that live on such water and this may have direct health implications. The mine dump consists of huge heaps of spoil rocks and cover soil that were removed "Fig. 3a". This heap of waste is steadily washed down by rain water, soluble contents are dissolved and flow down gradient from the hill into the surrounding stream. The pits created were filled with rain runoffs resulting in the formation of artificial lakes which can directly focus contaminated surface water into ground water or they may flow on the surface as runoffs to nearby stream "Figure 3b". Their activities also involve the alteration of the topography and the destruction of vegetation. These illegal miners consisted mainly of poor subsistence farmers, women and children as was observed by [8], [9].

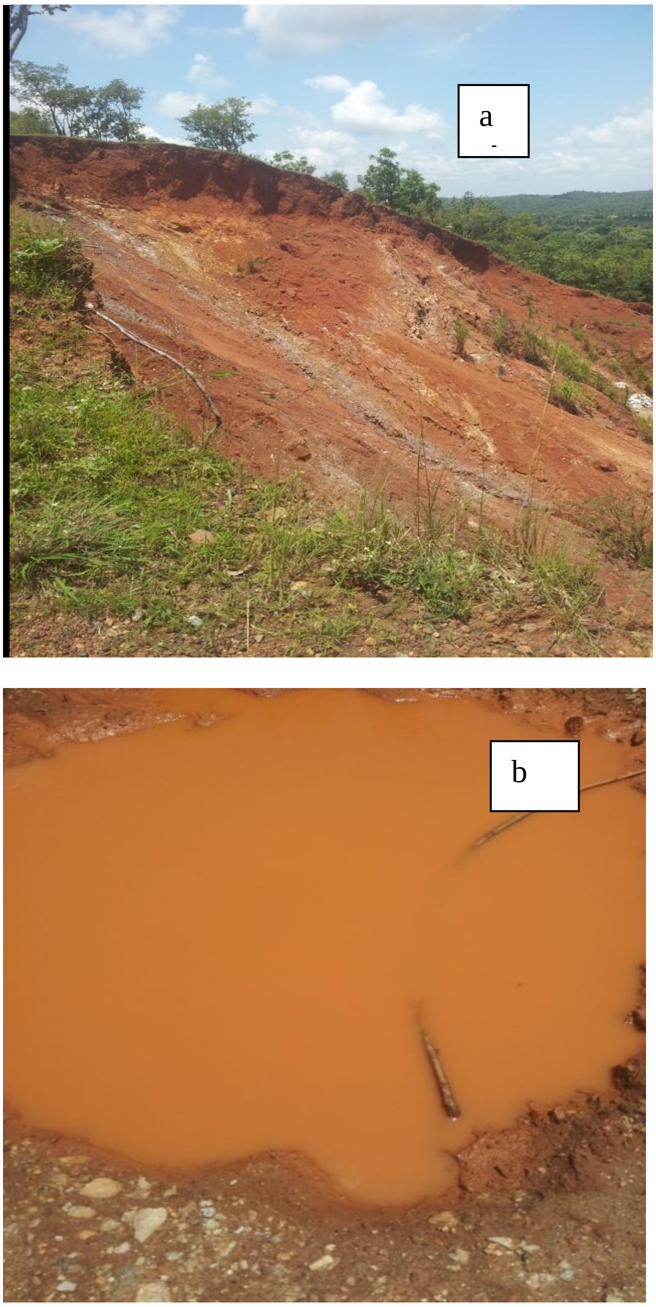



Fig. 3: photographs showing (a) topography damage and (b) the artificial pond created as result of excavation for marble

### 3.3 Results of chemical analysis

The results of the geochemical analyses of water samples from the study area are presented in the Tables 1-4 below.

Table 1: Concentration of heavy metals in surface water in Kwakuti

| Parameter | Units | point 1 | Point 2 | Point 3 | Point 4 | Point 5 | Mean | [6] | [7] |
|---|---|---|---|---|---|---|---|---|---|
| $As^{3+}$ | mg/l | >0.01 | >0.01 | >0.01 | >0.01 | >0.01 | >0.01 | 0.01 | 0.01 |
| $Pb^{2+}$ | mg/l | 0.32 | 0.45 | 0.47 | 0.36 | 0.48 | 0.42 | 0.01 | 0.01 |
| $Cu^{2+}$ | mg/l | ND | ND | ND | ND | ND | ND | 2 | 1 |
| $Zn^{2+}$ | mg/l | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | - | 3 |

Table 2: Concentration of cations in surface water of the study area

| Parameter | Unit | Point 1 | Point 2 | Point 3 | Point 4 | Point 5 | Mean | [6] | [7] |
|---|---|---|---|---|---|---|---|---|---|
| $Ca^{2+}$ | mg/l | 18.51 | 53.13 | 52.64 | 48 | 60.11 | 46.48 | ------ | ----- |
| $Mg^{2+}$ | mg/l | 15.21 | 30.01 | 28.5 | 33.4 | 33.4 | 28.12 | ------ | 0.2 |
| $Na^{2+}$ | mg/l | 3.71 | 3.5 | 3.5 | 2.78 | 3.5 | 3.39 | 200 | 200 |
| $K^{+}$ | mg/l | 2.2 | 2.53 | 2.73 | 2.19 | 2.63 | 2.46 | ------ | ----- |
| $Fe^{2+}$ | mg/l | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | | 0.3 |

Table 3: Concentrations of anions in surface water of the study area

| Parameters | Unit | Point 1 | Point 2 | Point 3 | Point 4 | Point 5 | Mean | [6] | [7] |
|---|---|---|---|---|---|---|---|---|---|
| $SO_4^{2-}$ | mg/l | 0.001 | 0.013 | 0.014 | 0.015 | 0.004 | 0.0094 | 250 | 100 |
| $HCO_3^{-}$ | mg/l | 12 | 15 | 16 | 15 | 11 | 13.8 | ------ | ------ |
| $NO_3^{-}$ | mg/l | 0 | 0 | 0 | 5 | 20 | 5 | 50 | 50 |
| $PO_4^{2-}$ | mg/l | 0 | 0 | 0 | 0 | 0.125 | 0.025 | ------ | ----- |
| $CL^{-}$ | mg/l | 20 | 22.13 | 23.01 | 23.41 | 23.1 | 22.33 | 250 | 250 |
| $NH_3$ | mg/l | 0.36 | 0.01 | 0.02 | 0.02 | 0.35 | 0.38 | ----- | ------ |

Table 4: Physical parameters measured surface water in Kwakuti.

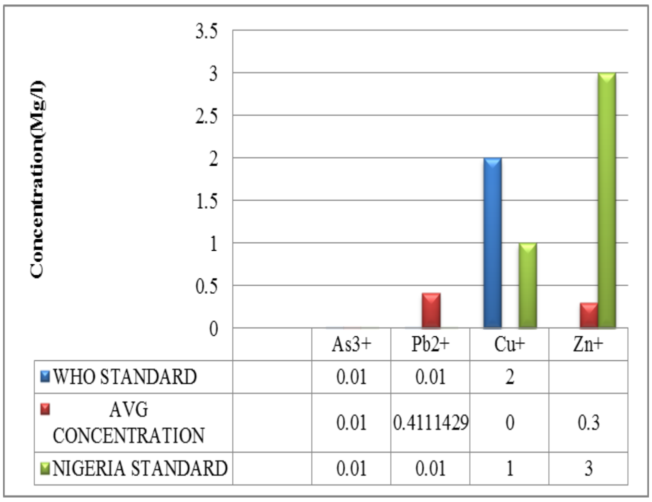
| Parameters | Units | Point 1 | Point 2 | Point 3 | Point 4 | Point 5 | Mean | [6] | [7] |
|---|---|---|---|---|---|---|---|---|---|
| TDS | ppm | 65.3 | 63.4 | 65.13 | 66.5 | 95 | 71.1 | ----- | 500 |
| Conductivity | μS/cm | 98 | 95 | 96 | 101 | 146 | 107.2 | ----- | 1000 |
| $P^{H}$ | | 6.89 | 7.1 | 7.61 | 7.12 | 7.37 | 7.22 | 6.5-8.5 | 6.5-8.5 |
| Temperature | $^{0}C$ | 23.31 | 27.1 | 27 | 27.03 | 27.03 | 26.3 | ----- | Ambient |

1. Heavy metal concentration

From the results of the analyses, arsenic ($As^{3+}$) has a concentration less than 0.01 mg/l and lies well within the allowable limits permitted by the world health organization and the Nigerian standard which gives a maximum allowable concentration of 0.01 mg/l [Table 1] and "Fig." 4. Lead ion ($Pb^{2+}$) has an average concentration of 0.42 with the highest values of concentration obtained at point 5 ( 0.48 mg/l) which is due to industrial processes taking place at the fertilizer company that quarries marble in a nearby area for such purpose. Point 1 has the lowest concentration value of 0.32 mg/l and this becomes a serious problem as this point 1 is the main source of domestic water supply in Kwakuti area because the maximum allowable limits given by the WHO and the SON is only 0.01 mg/l and this location has a concentration of 0.32 mg/l. The accumulation of lead in the surface is probably influenced by the chemistry of the crystalline basement rocks because lead usually occurs in certain crystalline rocks. Lead is a chalcophile element that forms numerous significant minerals including galena (PbS), anglesite ($PbSO_4$), cerussite ($PbCO_3$) and minimum ($Pb_3O_4$). It occurs widely at trace levels in a variety of minerals, including potassium feldspar, plagioclase feldspar, mica, zircon and magnetite.

The $Pb^{2+}$ ion has intermediary size between $K^+$ and $Ca^{2+}$ thus it readily replaces these ions in mica, potassium-feldspar and to a smaller degree, plagioclase and apatite. As a result of this chemistry, $Pb^{2+}$ is readily abundant in felsic igneous rocks in comparison to mafic rocks [10]. The abundance of lead in felsic igneous rocks is established by the values given by: ultramafic, 1 mg/kg; basaltic, 6 mg/kg; granitic, 15–19 mg/kg; syenite 12 mg/kg; and a crustal concentration of about 13 mg/kg. This explains the concentration of lead in the water samples. The natural lead (Pb) concentration in the soil which in turn affects the water that drains it is related to the chemistry of the parent rock. Generally, the species of lead differs significantly with different soil types; it is usually related to clay minerals, iron and aluminum hydroxides and organic materials. Lead may also be extremely concentrated in Calcium carbonate particles or in concentrations of phosphate [11]. The baseline value for lead in surface soil on the acceptable global scale has been projected to be 25 mg/kg and concentration values above this level indicates an anthropogenic control [11]. Although the values observed within Kwakuti are quite higher than the acceptable standards of water quality but since it lies within this base value, it can be concluded that the lead concentration resulted from the weathering of rocks containing feldspar and or calcium carbonates.

Copper ($Cu^{2+}$) was not detected during the course of the analyses. The average concentration of Zinc ($Zn^{2+}$) within Kwakuti is 0.30 mg/l and conforms to the standards given by [6] and [7]. The pollution of a stream or river water due to the concentration of heavy metals has become a significant issue in recent years because of their toxicity and the tendency to accumulate in the human system.

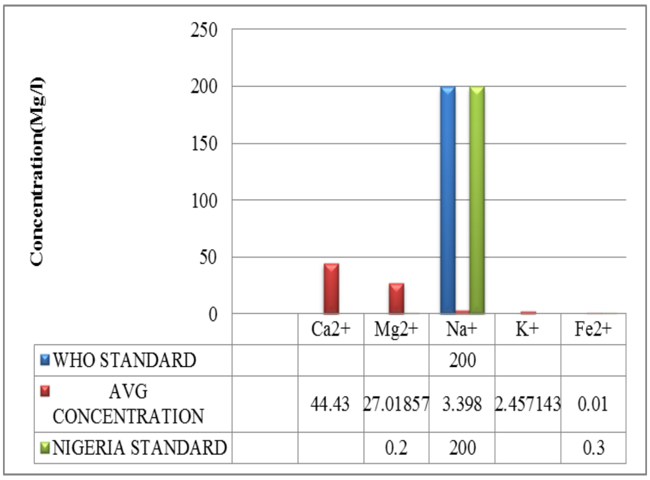



| | As3+ | Pb2+ | Cu+ | Zn+ |
|---|---|---|---|---|
| WHO STANDARD | 0.01 | 0.01 | 2 | |
| AVG CONCENTRATION | 0.01 | 0.4111429 | 0 | 0.3 |
| NIGERIA STANDARD | 0.01 | 0.01 | 1 | 3 |

Fig. 4: A bar chart showing the comparisons between the average concentrations of heavy metals in surface water in Kwakuti to the [6] and [7]

2. Cations concentration

The sequence of mean concentration values of cations in the water samples from Kwakuti is $Ca^{2+} > Mg^{2+} > Na^{2+} > K^+ > Fe^{2+}$. The concentration of $Ca^{2+}$ ranges from 18.51-6011 mg/l with an average value of 46.48 mg/l. $Mg^{2+}$ ranges from 15.21-33.40 mg/l with an average value of 28.12 mg/l which is practically higher than the allowable maximum limits [Table 2] and "Fig. 5." At point 1 which is the drinking water source in the area, the value of $Mg^{2+}$ is 15.21 mg/l while the allowable maximum limit is 0.20Mg/l. This concentration of $Mg^{2+}$ may be due to water-rock interaction caused by the presence of magnesium in dolomite marble. Aluminum is commonly available in the human diet. For adults, aluminum daily intake has been estimated to be at about 2.5-13.5 mg and may be much higher (up to 500 mg or more) in persons using antacids that contain aluminum hydroxide. The recommended levels of aluminum intake have not been associated with any adverse health conditions. $Na^{2+}$ ranges in values from 2.78-3.50 mg/l which lies well within the allowable limits of 200 mg/l. $K^+$ is more abundant at point 5, $Fe^{2+}$ has a concentration that lies well within the allowable maximum values of 0.3 mg/l given by [6] and [7].

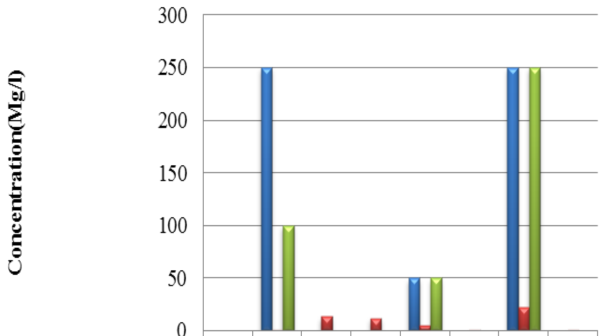



| | Ca2+ | Mg2+ | Na+ | K+ | Fe2+ |
|---|---|---|---|---|---|
| WHO STANDARD | | | 200 | | |
| AVG CONCENTRATION | 44.43 | 27.01857 | 3.398 | 2.457143 | 0.01 |
| NIGERIA STANDARD | | 0.2 | 200 | | 0.3 |

Fig. 5: A bar chart showing the comparison the average concentrations of cations in Kwakuti to the [6] and[7].standards

3. Anions concentration

The sulphate ($SO_4^{2-}$) concentration ranges from 0.01 to 0.015 mg/l with a mean value which is within the range suggested for drinking water by [6]. “Ref.[12]” reported mean value of 84.63 mg/l in the groundwater of Ewekoro cement factory environment. The concentration at point 1 is 0.01 mg/l which is the drinking water source in area. This value is quite below the maximum allowable concentration of 250 mg/l given by the world health organization and 100 mg/l given by the Nigerian standards. The highest value of this concentration is recorded at point 4 having a value of 0.015 mg/l and it still lies within the limits of tolerance. The chloride ion ($Cl^-$) concentration ranges from 20.00 to 23.41 mg/l with the values lying within the 250 mg/l recommended by WHO recorded within Kwakuti. Nitrate ($NO_3^-$) is recorded at only points 4 and 5 with concentration values of 5 and 20 mg/l respectively and is quite below the maximum allowable limit of 50 mg/l given by [6] and [7]. The concentration of $HCO_3^{2-}$ within the study area ranges from 12-15 mg/l with a mean value of 13.8 mg/l [Table 3] and “Fig. 6.” The concentration might have resulted from the dissolution of $CO_2$ gas possibly produced by anoxic biodegradation of organic materials in wastes water, mine dumps and landfills.




| | SO4 2- | HCO 3- | CO3- | NO3 - | PO4 2- | Cl- | NH3 |
|---|---|---|---|---|---|---|---|
| WHO STANDARD | 250 | | | 50 | | 250 | |
| AVG CONCENTRATION | 0.0094 | 13.8 | 12.004 | 5 | 0.025 | 22.23 | 0.152 |
| NIGERIA STANDARD | 100 | | | 50 | | 250 | |

Fig. 6: A bar chart showing the comparisons between the average concentrations of cations in Kwakuti to the [6] and [7]

There is a close relationship that exists between the quality of water and land use [13]. Different use of land can result in water pollution. Probable causes of water contamination include solid waste landfills from mines and quarry, cemetery and animal wastes resulting from human activities amongst others. In Kwakuti and its vicinity, the sources formerly mentioned might be responsible for sulphate, phosphate and nitrate concentration recorded in the area for the reason that the environment is rural, agricultural based with mining activities. Nitrate concentration ranged between 5.0 to 20 mg/l which were all within [6] acceptable limit of 50 mg/l for drinking water. High nitrate concentration negatively affects the capacity of the blood to carry oxygen which results in met-hemoglobinemia having the symptoms of paleness, bluish mucous membranes, digestive and respiratory tract complication [14]. If leachates are released from landfills and open dumpsites to the contiguous environment (as obtained at the quarry site at Kwakuti) devoid of appropriate handling, it can pollute the water resources. Studies have indicated that leachates can enhance the dissolution of inorganic materials or substances such as chlorides, bicarbonates, sodium, sulphate and potassium content of water [15].

4. Physical parameters

The range of $p^H$ values measured in Kwakuti ranges from 6.89-7.61 which are below 6.5 to 8.5 recommended by [6] for drinking water. Table 4 above indicates that all the water samples collected from Kwakuti are alkaline in nature. The temperature of water is the most important factor of the water which has a great deal of control on the different chemical and biological reactions taking place in water. The range of temperatures recorded in Kwakuti is 23.31 to 27.10°C. The values of electrical conductivities (EC) of the samples range from 95 to 146µS/cm. This has a mean value of 107.2µS/cm which lies within the maximum allowable limits of µS/cm1000 provided by the [7] for drinking water.

Generally, the physical and chemical properties studied in the surface water of Kwakuti area indicated that they are not in any way appropriate for drinking. The concentration of calcium ($Ca^{2+}$), magnesium ($Mg^{2+}$), bicarbonates ($HCO_3^{2-}$) and $p^H$ are due mainly to the water-rock interactions/reactions and the quarry operations has minimal effects on the concentration of these pollutants. The concentration of the heavy metals lies well within the acceptable standards except for lead ($Pb^{2+}$) concentration which can be associated with the water-rock reaction due to the presence of lead in k-feldspars, plagioclase or clay minerals. The cation concentration are within acceptable limits except for the concentration of magnesium ($Mg^{2+}$) whose concentration is higher than WHO recommended limit in drinking water. It is observed the dominant pollutants impacting on the surface water of Kwakuti comprises of lead ion ($Pb^{2+}$) and magnesium ion ($Mg^{2+}$) and that their concentrations are higher than recommended standards given by [6] and [7]. This makes the water unsuitable for domestic purposes such as cooking, drinking and so on. The values of the concentrations of these pollutants can make the water unsuitable for agricultural purpose like irrigation as the pollutants become accumulated in plants as well. Also, in livestock keeping, the use of such stream water as the drinking water source for live stocks can be dangerous for their health which may as well affect the humans that kill them for food.

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