Continental J. Applied Sciences 7 (2): 42 - 49, 2012 ISSN: 1597 – 9928

http://www.wiloludjournal.com
Printed in Nigeria doi:10.5707/cjapplsci.2012.7.2.1.8

THE HYDROCHEMISTRY OF PARTS OF BARKIN LADI, NORTH-CENTRAL NIGERIA

Joyce Moendess Ramadan and John Pam Chongs
Department of Mineral Resources Engineering, Plateau State Polytechnic, P.M.B 02023, Barkin Ladi.

ABSTRACT
This study was undertaken to identify contaminants and major sources of the contaminants of surface water in relation to past land -use (mining and agricultural activities). A pair of twelve (12) surface water samples were collected in sterilized containers and taken to the laboratories. These were examined for sodium, calcium, magnesium, potassium, iron ,lead, arsenic and cadmium . Also the microbial analysis of the water samples was carried out to determine the coliform present in the water. The pH and temperature were determined *in situ*. The results of the chemical analysis revealed all samples contain arsenic above the WHO standard, similarly a total of seven (7) samples collected at P3 ,P4, P6,P10, P11, and P12 were in excess of iron as against the WHO standard. In the same way, five (5) samples (P1, P7, P8, P9 and P10) contained lead beyond the required standard. The microbial analysis uncovered that all the samples amassed within the study area were contaminated with coliform as these were compared with the World Health Organization (WHO) standard for drinking water. The chemical make-up of the water in these bodies is apparently related to the mineral deposits mined out in the ponds, the geology of the area and the anthropogenic activities within the area. This substantiated the existence of health hazards.

KEYWORDS: Contaminants, Water, Chemical, Microbial, Analysis, Hazards.

INTRODUCTION

The area under investigation is located in Barkin Ladi Local Government Area (LGA) of Plateau state, north - central Nigeria, it is bounded by latitudes $9^0$32' and 9°35' N and longitudes 8° 53' and 8° 55' E sited on Naraguta sheet 168. Generally the study area is accessible through the Jos - Barkin ladi - Mangu road, other areas are linked together by untarred road and footpaths (Fig. 1). It covers a total area of about 12km^2 and it is underlain predominantly by the Younger Granite rock types (porphyritic biotite granite, porphyritic biotite hornblende granite, Sho granite porphyry, Laterite covering older basalt and Kassa Biotite granite) as seen on figure 2. These rock types are characterized with some metallic ore deposits such as the cassiterite, columbite and other associated minerals. This therefore attracted a lot of mining activities in the locality in the early 1960's, shortly after the Tin miners left the Jos Plateau (early 1980's) most of the abandoned mining ponds in Barkin Ladi and environs were converted to serve as sources of domestic, commercial, agricultural and industrial purposes to the surrounding communities which include, Kassa,, Gangare, Hwol, Kassa, Bet etc. The supply is made without any form of treatment, to our knowledge, virtually all aspects of living is being affected owing to the intake of these contaminated sources of water which has led to the spread of diseases like cholera, dysentery, typhoid-fever etc, subsequent low level of education and high level of poverty. Possible sources of water pollutants/contaminants within the area include the dissolution of some of the minerals/trace elements that make up the rocks, application of fertilizer, open defecation etc. that are often washed and deposited in numerous surrounding surface waters.

Normally, the chemical composition of water is controlled by basically three main factors, underlying geology, the atmospheric precipitation and biological or human factors (Alaez *et al*, 2006). Also factors such as the soil type, the water flow pattern and the geochemical processes interacting in the aquifers can also lead to considerable chemical variability.

This research intends to carry out the chemical analysis of water used for domestic, agricultural and industrial purposes within the study area. The achieved results will be compared with the World Health Organization (WHO) standards for drinking water. In the end, treatment stages will be recommended before use, which if adopted will definitely minimize the adverse effects on consumers.

MATERIALS AND METHODS

A total of twenty four (24) samples of surface water were collected from different strategic points within the study area. These were collected in sterilized polythene bottles and were taken to the laboratory for analysis. Subsequently, the location coordinates of the well were determined and recorded, using a GARMIN Etrex Portable global positioning system (GPS) unit as shown in figure 3.

Chemical and microbial analysis was carried out on all the water samples that were collected. The *Inductive Couple Plasma Optical Emission Spectrometer method* was used for the chemical analysis while the microbial analysis was achieved through the *Most Probable Number (MPN)* technique.

Chemical analysis

Each of the samples was acidified by adding few drops of hydrogen trioxonitrate (V) for the purpose of preservation. Subsequent filtration process was done for each sample to remove macro-organisms and other unwanted materials present. The samples were then passed into the Inductively Coupled Plasma Optical Emission Spectrometer (ICP - OES). This method is used for bulk elemental chemical analysis of water, it measures the ionic species present in the water samples.

Bacteriological analysis

In practice, the bacterial examination of water intended for human consumption is usually limited to a search for coliform bacteria (Price, 1985).

The water samples collected were physically examined for turbidity and presence of colloids and other suspended particles. These samples were subsequently transported to the laboratory for further analysis to determine the coliform population. The population was estimated by the Most Probable Number (MPN) technique, adopted from the Water, Sanitation and Health Electronic Library. This technique is used to estimate microbial population size.

Nine (9) tubes of 10 ml of lactose broth were engaged for each sample. Three (3) tubes of 10 ml, 1 ml and 0.1 ml of each sample were inoculated into 10 ml of the lactose broth, i.e. 10 ml of sample into three tubes of 10 ml lactose broth, 1 ml of sample into another three tubes of 10 ml lactose broth and then 0.1 ml of the same sample into three tubes of 10 ml lactose broth. This was done for each sample, and the inoculated samples then incubated at 37^0C for 24 hours. The control experiment was distilled water with zero coliform count per 100 ml.

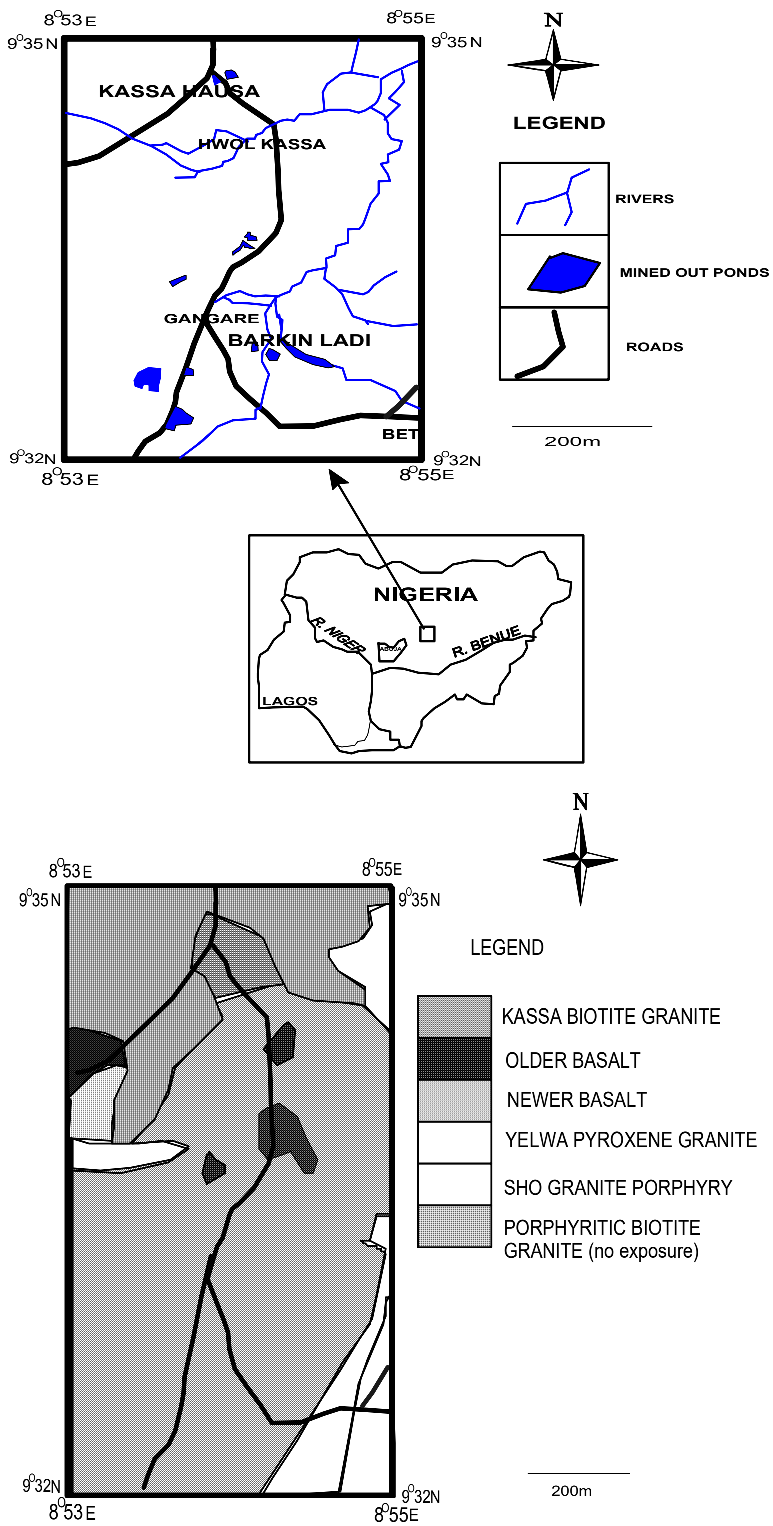

Fig. 2. Outline of the rock units within the study area (modified after MacLeod *et al*., 1971)

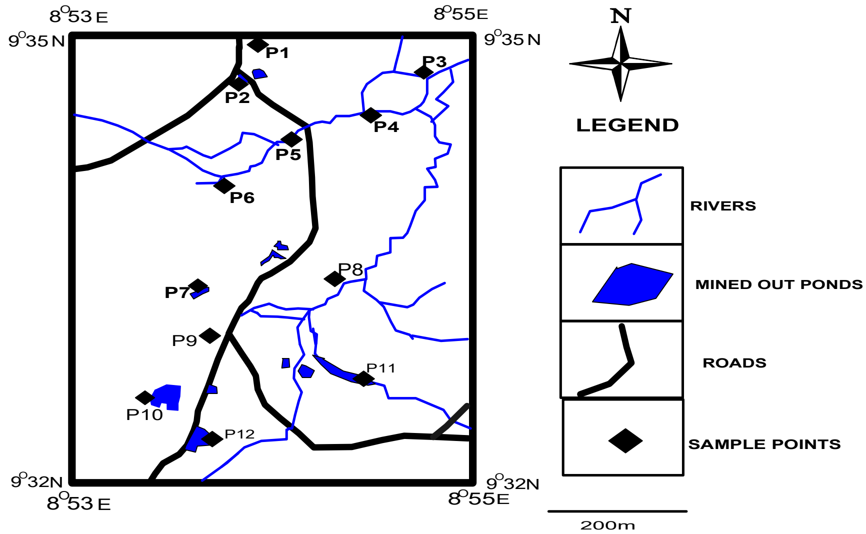

Fig. 3 Map of the Study Area showing drainage, ponds and sample points

The materials used are pipette, conical flask, measuring cylinder, hot plate, autoclave, test tubes, Durham tubes, foil papers, Petri dish, incubator, sterilized polythene bottles and water samples. The most typical colonies were selected from the EMB plates and were counted as total coliforms present.

NOTE – *Escherichia coli* produce characteristic colonies, small, dark, almost black centers with greenish metallic sheen. Enterobacter produces large pink mucrid colonies constitutes a confirmed test i.e coliforms present.

RESULTS AND DISCUSSIONS

Based on the chemical analysis of the water samples collected from the study area, the following chemical characteristics of the water were determined and compared with the world Health Organization (WHO) standard for drinking water as presented in Table 1.

Table 1 presents values obtained from the chemical analysis done. These values were put side by side with the WHO standard to ascertain the water quality within the study area. All the samples collected contain arsenic above the permissible level, also, seven (7) samples i.e P3, P4, P6, P7, P10, P11 and P12 contain anomalous quantity of iron (Fe). Furthermore lead (Pb) above the required standard was verified in five (5) samples (P1, P7, P8, P9, and P10). On the contrary, all the other elements assessed were tolerable as they did not surpass the WHO maximum permissible level.

Table 1: Results of Chemical Analysis of Water samples

Sample no	GPS locations	Temp(^{0}C)	pH	As (mg/l)	Ca (mg/l)	Fe(mg/l)	Mg (mg/l)	Pb (mg/l)	Cd (mg/l)	Na (mg/l)	K (mg/l)
P1	N 9^0 50’ 159’’ E 8^0 90’ 168’’	23.1	6.40	0.282	1.909	0.201	0.205	0.019	0.001	3.621	4.731
P2	N 9^0 57’ 412’’ E 8^0 90’ 753’’	23.2	6.89	0.176	3.393	0.232	0.767	0.013	0.003	3.037	3.816
P3	N 9^0 56’ 316’’ E 8^0 90’ 758’’	23.6	6.89	0.180	0.349	0.570	0.327	0.014	-	3.214	3.702
P4	N 9^0 56’ 307’’ E 8^0 90’ 94’’	23.4	6.47	0.182	3.722	0.365	0.955	0.016	0.009	3.512	4.651
P5	N 9^0 54’ 121’’ E 8^0 88’ 524’’	24.2	6.42	0.229	3.228	0.166	0.679	0.001	0.010	3.015	3.410
P6	N 9^0 54’ 159’’ E 8^0 90’ 166’’	23.4	6.51	0.285	3.433	3.080	1.514	0.010	-	3.621	3.316
P7	N 9^0 57’ 410’’ E 8^0 90’ 120’’	23.3	6.72	0.281	3.490	1.860	1.367	0.027	0.007	4.091	3.521
P8	N 9^0 56’ 350’’ E 8^0 90’ 190’’	23.1	6.60	0.341	3.287	0.127	1.069	0.017	0.005	3.500	3.418
P9	N 9^0 54’ 121’’ E 8^0 90’ 480’’	23.5	6.50	0.242	2.547	0.021	0.652	0.005	-	2.101	3.381
P10	N 9^0 55’ 164’’ E 8^0 90’ 480’’	23.4	6.49	0.341	3.633	1.017	0.784	0.007	0.009	3.626	3.550
P11	N 9^0 55’ 139’’ E 8^0 90’ 268’’	24.1	6.48	0.221	2.014	0.448	2.921	0.012	0.010	3.001	3.351
P12	N 9^0 53’ 359’’ E 8^0 90’ 188’’	24.0	6.43	0.082	2.210	0.310	1.460	0.003	0.001	3.457	3.301
WHO maximum permissible level			6.5-8.5	0.01	> 10	0.3	10	0.01	0.4	10	10

Arsenic

According to the WHO guidelines for drinking water quality (1993), 0.01mg/l is the provisional limit value for arsenic, and this is intended for use as a basis for the development of national standards in the context of local or national environment, social, economic and cultural conditions (www.epa.gov/ogwdw/arsenic/index.html). When arsenic occurs in water, the source is almost always a natural source as arsenic is a part of the earth's crust and occurs naturally in soils and rocks. The health effect of arsenic depends on its chemical form, how much it is consumed and for how long. Long-term exposure to arsenic can cause a lot of harmful effects to the body including nervous system effects, diabetes skin problems, high blood pressure, reduced intelligence in children, cancer and several circulatory diseases (www.aglimmerofhope.org/).

Iron

Iron is not hazardous to health when present in drinking water (www.medicinet.com/18865) . however, as little as 0.3mg/l can cause water to turn a reddish brown colour. This gives a disagreeable metallic taste and usually can cause an offensive odour when it exists along with certain kinds of bacteria.

Lead

Lead is one of the most common chemicals which contaminate public water supply and is certainly one of the most harmful. There is no safe level for lead exposure. The degree of exposure depends on the concentration of lead, route of exposure (air, water or food) and age of the victim(s) (www.who.int/water_sanitation_health/dwq/chemicals/lead.pdf). Drinking water is one of the most common routes of exposure to lead contamination, but it is one of the easiest routes of contamination to reduce. High levels of lead contamination in a child can result in convulsions, major neurological damage, organ failure, coma and ultimate death; in adults, it leads to reduced fertility and low sperm count in men. Moderate to low levels of exposure may result in hearing loss, inhibit growth and cause learning disabilities http://water.epa.gov/drink/info/lead/index.cfm. Unlike other contaminants, lead will accumulate within the body over time, it will tend to be stored in the brain, bones, kidneys and other major organs. And long term exposure can result in decreased functions of the nervous system, weakness in fingers, wrists or ankles. It is pertinent to note that some of the effects of lead poisoning cannot be cured, but it is possible to reduce exposure to lead.

The bacteriological examination of the water samples collected revealed the presence of coliform in all the samples as seen on Table 2.

Table 2: Physical Examination and Results of Microbiological Analysis of water samples

Sample No.	Physical observation	Reaction with Lactose broth acid/ gas	3 of 10 ml	3 of 1 ml	3 of 0.1 ml	MPN/100 ml of sample	WHO maximum permissible level
P1	clear	+ +	0	1	0	3	0
P2	clear	+ +	1	1	0	7	0
P3	clear	+ -	1	2	0	4	0
P3	Colloidal	+ -	1	2	0	9	0
P4	clear	+ +	1	2	0	4	0
P5	clear	+ -	2	0	1	14	0
P6	clear	+ +	1	2	0	11	0
P7	colloidal	+ +	1	2	0	11	0
P8	Cloudy	+ -	2	2	1	22	0
P9	Cloudy	- +	2	0	1	14	0
P10	clear	+ +	1	1	0	10	0
P11	Colloidal	- +	2	2	1	2	0
P12	clear	+ -	0	1	0	3	0

Coliform

Coliforms are bacteria that are always present in the digestive tracts of animals including humans and are found in their wastes. The presence of coliforms in water may not be directly harmful and does not necessarily indicate the presence of faeces, however, it does indicate an increased likelihood of harmful pathogens in the water (www.bfhd.wa.gov/info/coliform.php).

Based on this, it is suggested that the sources within the study area are contaminated and not safe for consumption. In fact, the World Health Organization (WHO) guidelines of 1996 stipulated that all water intended for drinking must have zero coliform (*Escherichia coli, Salmonella species, Shigella species*, etc.) count in any 100 ml sample of water. Generally, however, water of good quality is expected to give a low/zero coliform count (Pelczar *et al*., 1993). Therefore, the water quality results from the study area disclose a poor value. The presence of *Escherichia coli* in drinking water and food causes diarrhoea, which is a major childhood disease in the tropics, than any other bacteria (Antai and Anozie., 1987), sometimes it causes severe bloody diarrhoea and abdominal cramps, in children under 5 years of age and the elderly, the infection can cause complication called haemolytic uremic syndrome in which the red blood cells are destroyed and the kidneys fail. Therefore, reducing microbiological contamination should always be the priority because of the link to infectious diseases which may be acute, infectious and/or epidemic.

RECOMMENDATIONS

By way of alleviating the immediate and long term ill-effects that would be suffered by inhabitants within the study area, the following recommendations are made:

- Treatment of water that can effectively reduce arsenic levels in drinking water include specialty media, reverse osmosis systems with pre-oxidation and distillation systems.
- Treatment of iron in water can be effectively carried out by aeration, chlorination, greensand filtration, catalytic filtration and ozonation.
- Treatment of water contaminated with lead can be done by reverse osmosis, corrosion control, distillation units and carbon block filtration.
- The presence of coliform in the water could be treated using chlorine, ultra –violet light/ ozone (disinfection) or simply boiling the water before consumption, all of which act to kill or inactivate the bacteria.

REFERENCES

Alaez, C.F., Alaez, M.F., Dominguez, C.T and Santos, B.L (2006). Hydro Chemistry of North West Spain Ponds and its relationships to Groundwater. *Limnetica*, 25 (1-2), pp.433-452.

Antai, S.P and Anozie, S.O. (1987). Incidence of Infantile diarrhoea due to enteropathogenic *Escherichia coli* in Port Harcourt metropolis. *Journal of Applied Bacteriology*, 62 (3), pp 227-213

Brian. O.P. (2010). Drinking Water Help Guide. Retrieved May 9, 2012, from http://water.epa.gov/drink/info/lead/index.cfm

Coliform bacteria in drinking water supplies (2011). Retrieved May 10, 2012 from http://www.bfhd.wa.gov/info/coliform.php

Drinking Water and Health Fact Sheet (1996). U.S. EPA publ., Retrieved May 10, 2012 from http://www.epa.gov/ogwdw/arsenic/index.html

Environmental Health Fact Sheet (2010). Retrieved May 9, 2012 from http://www.aglimmerofhope.org/

Health and disability (2010): Retrieved May 9, 2012 from http://www.who.int/water_sanitation_health/dwq/chemicals/lead.pdfwww.medicinet.com/18865

MacLeod, W.N. and Turner, D.C. (1971). Geology of Jos Plateau. Bulletin 32, vol.2, Geological Survey of Nigeria.

Pelczar, M.J., Chan, E.C.S. and Krieg, N.R. (1993). Microbiology (5th ed.), Tata McGraw Publ. Co. Ltd., New Delhi, New York.

Price, M. (1985). Introducing Groundwater. Chapman and Hall, 2-6 Boundary Row, London.

WHO (1996). Guidelines for Drinking Water Quality. Second edition. vol 3. Surveillance and Control of Community Supplies.

Received for Publication: 16/08/12
Accepted for Publication: 11/11/12

Joyce Moendess Ramadan
Department of Mineral Resources Engineering, Plateau State Polytechnic, P.M.B 02023, Barkin Ladi.
Email: joycedakogol@yahoo.com