Assessment of ground water pollution in Itagunmodi, South-West, Nigeria

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Abstract

Some investigations have been carried out on geochemical characteristics of soil samples that embedded the ore deposits. Physiochemical analysis of water collected within gold mining area and the water consumed in the town of Itagunmodi was carried out to determine their hygienic conditions. The major objective of this study was to determine the suitability of the available water consumed in the town based on the Physiochemical analysis test carried out. In this regards, four major sources of water were analyzed. Analysis shows that the water within the town of Itagunmodi was hygienic with the inclusion of water within the mining site. The analysis includes; conductivity test, the pH test and others. It was noticed that the pH of the sample from the gold mining site was also suitable for drinking according to the World Health Organization standard. For a safe drinking water, the pH should be between (6.5 -8.5).

Keywords: Geochemical, Physiochemical analysis, conductivity, gold mining site, water.

1. Introduction

Water is essential to life and must not be considered as ordinary gifts. The need for Physiochemical analysis of water is very vital and all sources of water must be known before consumption. Drinking water or portable water is water of sufficiently high quality that can be consumed or used with low risk of immediate or long term harm. In most developed countries, the water supplied to households, commerce and is all of drinking water standard, even though only a very small proportion is actually consumed or used in food preparation.

In developing countries, not all the water available to all household is of drinking water standard. Although, commerce and industrial water supplied is of drinking water standard. Over large part of the world, humans have inadequate access to portable water and sources use are contaminated with disease vector, pathogens or unacceptable level of toxins or suspended solids. Such water is not portable and drinking or using such water in food preparation leads to widespread of acute or chronic illness and is a major cause of death and misery in many countries. Reduction of waterborne diseases is a major public health goal in developing countries. Typical water supply network deliver portable water from the tap, whether it is to be used for drinking, washing or landscape irrigation. One counter example is urban China, where drinking water can optionally be delivered by a separate tap, often in the form of distilled water or otherwise the regular tap water needs to be boiled.

Water has always been an important and life-sustaining drink to humans and is essential to the survival of all organisms (Greenhalgh, Alison, March 2001).Excluding fat, water composes approximately 70% of the human body by mass.

In many parts of the world the only sources of water are from small streams often directly contaminated by sewage. Most water requires some type of treatment before use, even water from deep wells or springs. The extent of treatment depends on the source of the water.

In emergency situations when conventional treatment systems have been compromised, water borne pathogens may be killed or inactivated by boiling but this requires abundant sources of fuel, and can be very onerous on consumers, especially where it is difficult to store boiled water in sterile conditions and is not a reliable way to kill some encysted parasites such as *Cryptosporidium* or the bacterium *Clostridium*. Other techniques, such as filtration, chemical disinfection, and exposure to ultraviolet radiation (including solar UV) have been demonstrated in an array of randomized control trials to significantly reduce levels of water-borne disease among users in low-income countries (Clasen et, al 2007), but these suffer from the same problems as boiling methods.

Clean drinking water is essential to humans and other life forms. Access to safe drinking water has improved steadily and substantially over the last decades in almost every part of the world. There is a clear correlation between access to safe water and GDP per capita.

In developing this Standard, references were made to the Nigerian Industrial Standards for Potable Water and Natural Mineral Water, the National Guidelines and Standards for Water Quality in Nigeria, the World Health Organisation (WHO) guidelines for drinking water quality (3rd Edition) and International Organisation of Nigeria (ISO).

Since gold is extremely resistant to weathering and, when freed from enclosing rocks, is carried downstream as metallic particles consisting of "dust," flakes, grains, or nuggets. Gold particles in stream deposits are often concentrated on or near bedrock, because they move downward during high-water periods when the entire bed load of sand, gravel, and boulders is agitated and is moving downstream. Fine gold particles collect in depressions or in pockets in sand and gravel bars where the stream current slackens. Concentrations of gold in gravel are called "pay streaks." This led to the analysis conducted on four water sources in Itagunmodi, western Nigeria. This work investigate the water collected within Itagunmodi gold mining site and the water consumed by the people of the town in other to determine the hygienic state since not all sources of water are consumable although, the water may appear colourless.

1.1 Location Itagunmodi is located on latitude (DMS) $7^{0}31'60''$ longitude (DMS) $4^{0}39'0''$ and altitude (meters) 347 the time zone is east (est). The approximate population for 7km radius from this point is 12655. Itagunmodi is a town very close to towns such as: Ile-Ife, Ilesa and Modakeke all in Osun State, Nigeria.

2.0 Soil type The sediment-hosted disseminated gold deposits (SHDGD) in Itagunmodi, Osun State, Nigeria is located in the clayey soil types derived from variably migmatised gneiss, biotite-and-biotite hornblende-gneiss and weathered amphibolites respectively.

2.1 Governing equation

2.1.1 Continuity equation (Conservation of mass):

The continuity equations is a conversation of mass equation for fluid flow. Fluid mass must always be conserved in fluid systems. This holds true for pipes, channels, and various other systems. The idea is that the mass into a system cannot disappear along the way, and an equal amount of mass must exit the system:

$$m_1 = m_2 \text{-------}(1)$$

where: m = mass or when applied to fluid flow,

$$Q_1 = Q_2 \text{-------}(2)$$
$$\rho_1 A_1 v_1 = \rho_2 A_2 v_2 \text{---}(3)$$
$$Q = Av \text{---------}(4)$$

where: **ρ** = density or mass density (kg/m^3, slugs/ft^3)

A = cross-sectional area of the flow (m^2, ft^2), **V** = velocity of the flow (ft/sec) *and* **Q** = discharge (ft^3/sec) and normally fluid can be assume to be incompressible so ρ_1=ρ_2 therefore:
Because liquids can be assumed to have constant density over fairly large vertical distances, the continuity equation simplifies to:

$$A_1 v_1 = A_2 v_2 \text{------}(5)$$

3.0 Experimental evaluation of Physiochemical parameters of ground water

3.1 Atomic Absorption Spectrophotometry

Atomic absorption spectroscopy (AAS) is a much more accurate and sensitive method of analyzing wide range of metals. The efficiency of detection is increased by overcoming the limitations associated with flame photometry. In this process, an atomized sample solution containing the metal is passed through the equipment (spectrometers). The atoms of the metal absorb energy when the radiation contains wavelengths that can cause the electrons of the metal to undergo transition into higher energy levels. The atomized sample absorbs the radiation, the intensity of the radiation is reduced and the reduction in intensity of the radiation is proportional to the concentration of the metal present. A radiation emanating from a cathode lamp made to pass through the free atoms will be absorbed by the atoms and the extent of this absorption is a measure of the concentration of the metal in solution. This absorbed light is actually what atomic absorption spectrophotometer picks up as current, amplified and recorded by an instrument such as a chart recorder or digital meter. Each metal has specific lamp, however multi- element lamps such as those for iron, zinc, calcium and magnesium is also available. Even though atomic absorption spectrophotometry can handle a wide range of metals however certain other metals may not be determined such as Fr, Ra, Ac, O, C, N, P ,S, all halogens, and all inert gases and these may require the use of inductively coupled plasma emission spectrophotometry.

In the analysis, atomic absorption spectrophotometer, (AAS) and Double-Beam atomic absorption spectrophotometer were used for the investigation.

3.2 Principle of Atomic Absorption Spectrophotometry (AAS) for Trace Element Analysis

The principle of Atomic Absorption Spectrophotometer (AAS) is based upon the concept that atoms of an element can absorb electromagnetic radiation. This occurs when the element is atomized and the wavelength of light absorbed is specific to each element. Thus the atomic absorption spectrophotometer comprises an atomizing device, a light source and a detector. A lowering of response in the detector during the atomization of the sample in a beam of light, as a consequence of atomic absorption, can be calibrated and is sensitive at the ppm level. The sample was prepared in a solution and aspirated via a nebulizer and atomized in an acetylene-air or acetylene- nitrous oxide flame.

3.3 Tests to Determine Overall Water Quality

ALKALINITY- Is the measurement needed to determine corrosivity.

CHLORIDE- High concentrations often indicate contamination by a septic system, fertilizer, a landfill or road salt.

CONDUCTIVITY- Measures the ability of water to conduct an electrical current; can be used to signal the presence of contaminants.

HARDNESS- Helps determine the need for water softening; also influence corrosivity.

PH- Indicates water's acidity and helps determine if water will corrode plumbing.

After running the initial set of tests, well users should continue to test for bacteria once in a year. It's also a good idea to test for nitrate annually for several years. However, a nitrate test should always be conducted if an infant is drinking the water.

3.4 Results of Physiochemical analysis on four sources of water in Itagunmodi

Deep well (DW) - Itagunmodi town

Steam (S) - mining site

Bore-hole (BH) - Itagunmodi town

Well (W) - Itagunmodi town

3.4.1 Sample calculation:

The following data were obtained from the analysis of water from Itagunmodi.

$$Total\ solids = \frac{(weight\ of\ dish + sample) - (weight\ of\ dish)}{volume\ of\ sample} \text{--------}(6)$$

$$Total\ dissolved\ solids - Total\ solids - Total\ suspended\ solids \text{------}(7)$$

Table 1: Showing the parameters analyzed in deep well and stream water

Parameters	Deep well (DW)	Stream (S)

	R1	R2	Av	R1	R2	Av
PH	7.140	7.100	7.120	7.830	7.830	7.830
Total solid mg/l	100.000	100.000	100.000	195.000	205.000	200.000
Total dissolved solid mg/l	190.000	210.000	200.000	400.000	400.000	400.000
Conductivity $\mu S / cm$	142.000	144.000	143.000	160.000	158.000	159.000
Total alkalinity mg/l	2.000	2.000	2.000	2.000	2.000	2.000
Total Hardness $CaCO_3$ mg/l	220.000	240.000	230.000	350.000	360.000	355.000
Mg, mg/l	8.600	8.400	8.500	11.900	11.600	11.800
Cl, mg/l	4.600	4.900	4.700	2.100	2.800	2.400
S, mg/l	0.075	0.068	0.072	0.071	0.072	0.072
Pb, mg/l	0.000	0.000	0.000	0.000	0.000	0.000
Cu, mg/l	0.070	0.060	0.060	0.080	0.120	0.100
Zn, mg/l	0.020	0.040	0.030	0.060	0.060	0.060

Table 2: Showing the parameters analyzed in bore-hole and well water

Parameters	Bore-Hole (BH)			Well (W)		
	R1	R2	Av	R1	R2	Av
PH	7.410	7.300	7.360	7.420	7.370	7.400
Total solid mg/l	350.000	200.000	275.000	220.000	280.000	300.000
Total dissolved	270.000	330.000	300.000	310.000	290.000	300.000

solid mg/l						
Conductivity $\mu S / cm$	459.000	455.000	457.000	418.000	416.000	417.000
Total alkalinity mg/l	3.000	3.000	3.000	2.000	2.000	2.000
Total Hardness $CaCO_3$ mg/l	370.000	350.000	360.000	290.000	280.000	285.000
Mg, mg/l	28.600	23.400	26.000	33.000	21.500	27.300
Cl, mg/l	8.500	7.100	7.800	3.900	4.600	4.200
S, mg/l	0.093	0.087	0.090	0.125	0.110	0.118
Pb, mg/l	0.000	0.000	0.000	0.000	0.000	0.000
Cu, mg/l	0.000	0.000	0.000	0.050	0.030	0.0400
Zn, mg/l	0.020	0.030	0.030	0.020	0.060	0.040

Figure 1: Plot of average parameters for deep well water

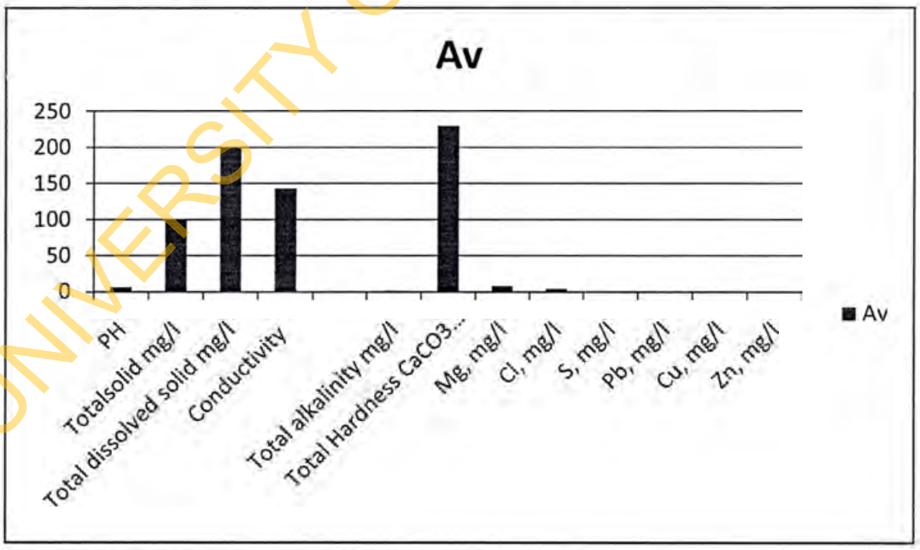


Figure 2: Plot of average parameters for stream water

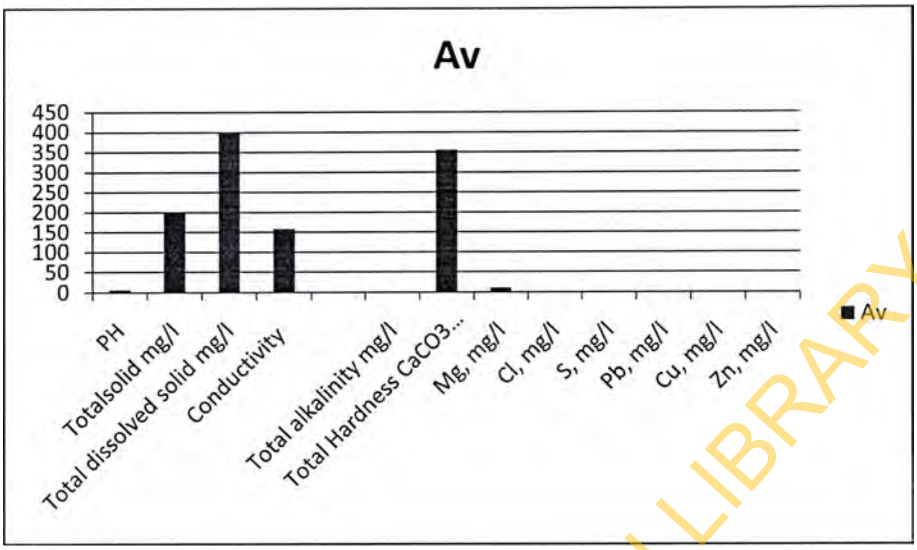


Figure 3: Plot of average parameters for bore-hole water

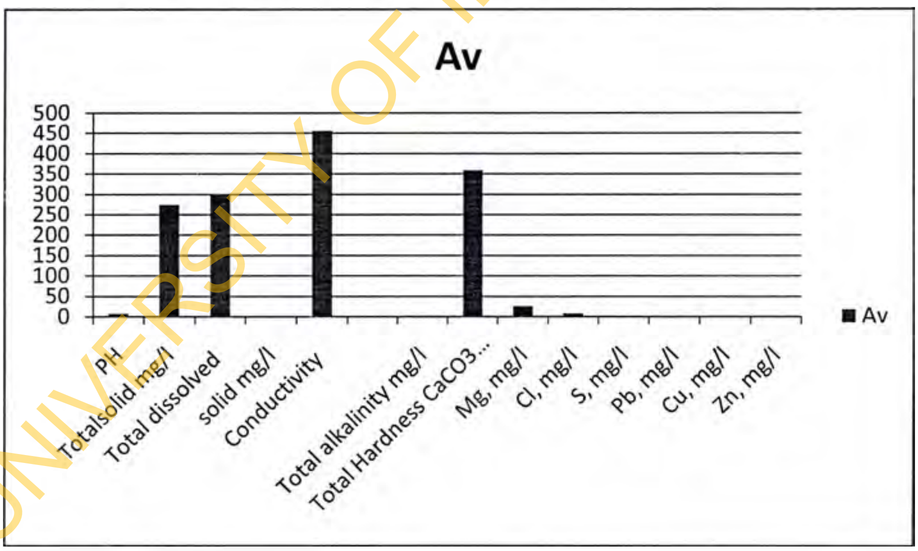
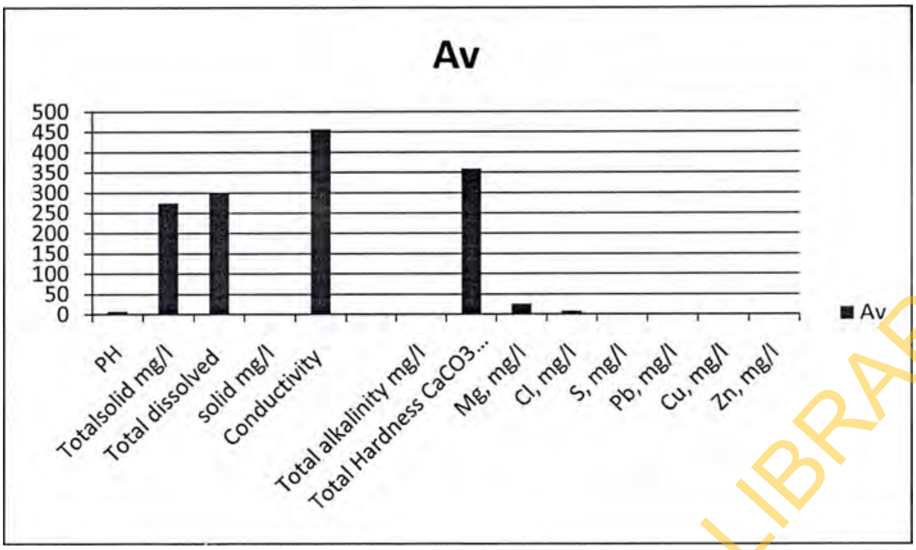


Figure 4: Plot of average parameters for well water



4. Discussion

The acceptable results for pH are values between 6.5 - 8.5 units, this occurs in most natural waters. The lower the pH, the more corrosive the water will be. The pH of sample collected from the gold mining site is safe drinking water; the average pH value is 7.83. Those samples within the town of Itagunmodi are also regarded as safe drinking water; the average pH values lies between 7.12 - 7.40. These values lie between the permitted ranges in drinking water quality standard used in Nigeria.

After running the initial set of tests, well users should continue to test for bacteria once in a year. It's also a good idea to test for nitrate annually for several years. However, a nitrate test should always be conducted if an infant is drinking the water. Low values are most often caused by lack of carbonate minerals, such as calcium and magnesium found in limestone. Water leaking from a landfill may also lower pH .Other analysis such as conductivity, total dissolved solids, chlorine, and lead, copper, zinc, and falls within the maximum permitted level with reference to Nigeria which are: 1000.00 $\mu S/cm$, 500.00 mg/l, 250.00 mg/l, 0.01 mg/l, 1.00 mg/l, and 3.00 mg/l. The maximum permitted level for magnesium in Nigeria is 0.20 mg/l, this value depend on consumer acceptability e.t.c., can be used to confirm the water samples as been hygienic for human consumption.

5. Conclusion

It conclusion, the result of the analysis carried out shows that the four sources of water in Itagunmodi were hygienic for human consumption.

6. Recommendation

Human activities such as the use of chemicals in agriculture, effluent from homes, and sewage disposal are all factors that contaminate water. Hence, it was recommended that physiochemical analysis should be carrying out from time to time. At least once every three years. And on site drinking water systems shall be checked at least every 3 years.(Nigerian Industrial Standard NIS 554: 2007)

7. References

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