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Toxicity Levels of Heavy Metals in Surface Water Resources around the Enyigba Lead- zinc Mining Area, Ebonyi State, and Southeastern Nigeria

Okabe, P. O[1], Obasi, P. N[1], Omeokachie[2], A. I[1]. Alieze, I. V[1]. and Ovu, S. C.[1]

[1]Department of Geology and Exploration Geophysics, Faculty of Science. Ebonyi State University. P.M. B 053, Abakaliki Nigeria.
[2]Department of Geological Science Nnamdi Azikiwe University Awka, Anambra State Nigeria.

Corresponding Author: Obasi, P. N; Email:obasiphilip26@gmail.com. Phone number: +2348060636246.

ABSTRACT

The assessment of toxicity levels of heavy metals of surface water resources of the Enyigba lead – zinc mining district has been carried out. Mining of lead-zinc and associated minerals has been on-going in the area for over nine decades. These minerals are hosted by the Albian Asu River shales. Ten (10) surface water samples were collected from (ponds, streams, rivers and abandoned mine pits) and analyzed using AAS machine to determine the total hydrochemical concentrations. The result shows that turbidity and pH are far above the WHO recommended standard for drinking water, which imply slightly acidic to basic water, while electrical conductivity and TDS are below. The high concentration of turbidity, indicate the rate of organic matter decaying in the water. There is high concentration of Fe^{2+} (0.000-31.578mg/L), Al^{3+} (0.00-1.65mg/L), As^{3+} (0.00-26.38mg/L), Cr^{3+} (0.00-0.891mg/L), Mn^{2+} (0.062-32.891mg/L), Ni^{2+} (0.00-0.149mg/L), Cd^{2+} (0.039-2.170mg/L), Mo^{2+} (0.00-0.153mg/L), Co^{+} (0.00-0.172mg/L), Pb^{2+} (0.00-2.728mg/L), Zn^{2+} (0.00-9.885mg/L), Se^{2+}(0.00-10.922mg/L) and Hg^{2+} (0.00-0.481mg/L) are of high concentrations, and Ag^{+} and Cu^{2+} has low concentrations. Based on WHO recommended limit, these high and low may be attributed to the dissolution of ore minerals which is not static in the area.

Keywords: Heavy metals, Hydrochemical, Surface water and Mining

1.0 Introduction

Water is the basic support for all forms of life (Vanloon and Duffy, 2005). Surface water sources include fresh water, lakes, rain water, lakes oceans, ponds and streams. Due to the easy- to- reach nature of surface water, many communities depend on solely on it for their existence. Toxic metals are usually present in industrial, municipal and urban runoff, which enters surface water and results to hydrochemical changes which can be harmful to humans and biotic life (Obasi et al. 2022; Moye et al 2007; Obasi and Akudinobi, 2020). Increased urbanization and industrialization are to be blamed for an increased level of trace metals, especially heavy metals, in our water ways (Seema Singh et al., 2011, Igwe et al. 2022; Obasi et al. 2019). Many dangerous chemical elements if released into the environment accumulate in the soil and sediments of water bodies. There are over 50 elements that can be classified as heavy metals, 17 of which are considered to be very toxic and relatively accessible. As toxicity level depends on the type of metal, its biological role and the type of organisms that are exposed to it. Heavy metals have a marked effect on the aquatic flora and fauna which through biomagnification enters the food chain and ultimately affect the human beings as well

(Ram S Lokhande et al.,2011). The heavy metals in drinking Water linked most often to human poisoning are: lead, iron, cadmium copper, zinc, chromium etc .They are required by the body in small amounts, but can also be toxic in large doses.

The presence of contaminants that deviate from the acceptable World Health Organisation (WHO) guideline values has been associated with the cause of different kinds of disease such as typhoid fever, dysenteries, gastrointestinal and infectious hepatitis (Hammer, 1996). However, water meant for drinking and cooking should be free from harmful microorganisms, harmful chemicals, suspended materials, undesirable taste, colour and odour (Leton and Umesi, 1990). The quality of surface water is dependent on natural factors (geological, topographical, meteorological, hydrological and biological) in the drainage basin and varies with seasonal difference in runoff volumes, weather conditions and water levels (Obasi and Akudinobi, 2013).

Enyigba is a mining district located about 14Km south of Abakaliki, Ebonyi State, Southeastern Nigeria. It stretches to neighboring villages like Amagu, Nwafogo, Alibaruhu, Nwakpu, Ameri, Ameka, Echara, Ohankwu and Mgbabo (Fig 1). Enyigba is renown because of the occurrence of the lead – zinc mineralization, with associated saline intrusion such as Enyigba salt lake. This mineralization has lead to illegal mining, gangue dumping, inappropriate deposition and disposal of mine waste. All these find their way into groundwater and surface water through leaching, infiltration, runoff and erosion. Surface water such as the Enyigba salt lakes, Akpara River, Ngele River, Ameka pond, Ameka stream, Nwakpu stream, Nwafogo stream and Ebonyi River are prominent.

These rivers provide aqueous media for the dissolution, transportation and movement of the chemical constituents in water. Obasi et al, 2015 carried out geochemical assessment of the Ameka mining area (Enyigba inclusive) and observed high pollution, contamination factor and geoaccumulation index for some heavy metals. Nnabo et al, 2011 and Ezeh, 2007 have carried out assessment of stream sediments of the Enyigba mining areas. Hence the need exists for the assessment of these metals in surface water of the area which are major receptacles of these constituents. Uma (1985) suggested that the pollution source might have been from improper refuse disposal and salt water intrusion contaminant from the host rock.

2.0 Physiography and Geology

The study area falls within the third climatic region of (Inyang, 1975) which was characterized by two major seasons namely; rainy season and dry season. The rainy season lasts for eight months, which start from March to October, with its peak in July through August and September. The average rainfall of Enyigba and environs is about 2125mm during the period of intense rainfall and slightly more than 250mm in the driest month (Inyang, 1975),

The study area is located within the Abakaliki Anticlinorium in the southern tip of the Benue Trough (Reyment, 1965). The area is underlain by Albian Asu River Shale. It composed of shales, mudstone, ironstones and thin beds of limestone. The shales vary from dark grey to light grey in colour and are very fissile. The shales are often calcareous and pyritic. The rocks are extensively fractured, folded and faulted following the Santonian epirogeny which strongly affected the Abakaliki area. This Sontonian event also accounts for the mineralization of the area (Kogbe, 1987)

3.0 Methodology

Ten water samples were collected from different surface water sources traversing different communities in the area as shown in fig.2. In-situ measurements of pH and electrical conductivity (EC) were carried out in the field while samples were collected in clean transparent ethylene - free plastic bottles, which were also rinsed with the water samples to be collected to avoid any form of contamination. pH of the water samples were measured by electrometric method using laboratory pH meter Model DDS - 307 according to America Public Health Association (APHA) 1999 guideline. Mercury thermometer was used to determine the temperatures of the water samples, METRO HM644 conductivity meter was used to measure electrical conductivity, turbidity of the samples were measured using turbidity meter. The heavy metal analysis was done using varian AA240 Absorption spectrophotometer (ASS) according to APHA, 1995 guidelines

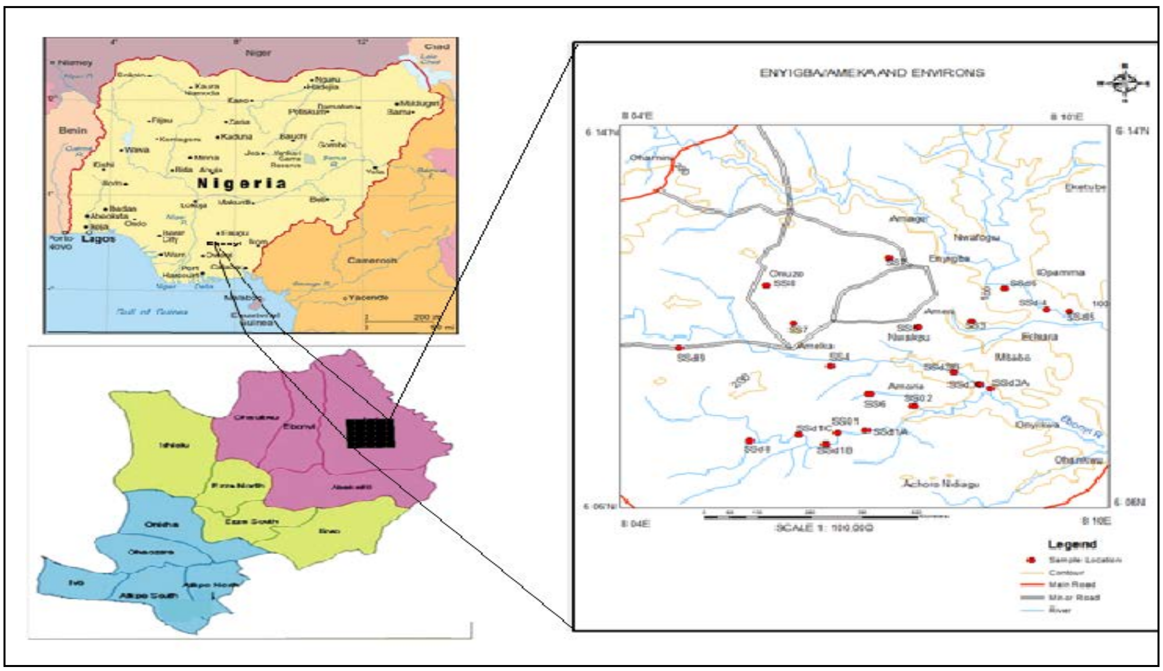

Figure 1. Map of Enygba with samples point and Lead-Zin mines.

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4.0 Result and Discussion

The result of hydrochemical analysis has been presented in table 1 below.

Table 1: RESULT OF HYDROCHEMICAL ANALYSIS

S/N	SampleNo.	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10	WHO 2008 (mg/L)
	LOCATION/ CORDINATE PARAMETERS	Beside Ishiagu bus st. 06º11'27.7"N 008º08'21.6"E	Behind Ishiagu bus st. 06º11'38.4"N 008º08'20.8"E	Enyigba mine 06º11'47.5"N 008º08'17.6"E	Ameri River 06º11'51.0"N 008º08'25.7"E	Nwakpu River 06º11'39.3"N 008º08'22.6"E	Akpary road 06º12'80.4"N 008º06'38.7"E	Ngele road 06º11'54.3"N 008º08'34.1"E	Enyigba salt lake 06º11'31.2"N 008º08'22.3"E	Ameka pond 06º09'54.5"N 008º06'69.1"E	Ameka stream 06º09'35.5"N 008º06'30.8"E	
1	PH	10.490	5.590	5.700	5.740	5.820	6.240	6.200	9.870	6.330	6.690	8.5
2	Turbidity NTU	17.00	9.000	3.000	14.000	9.000	0.022	323.0	433.0	848.0	0.009	5
3	Conductivity µS/CM	14.30	12.900	10.800	11.400	9.800	120.2	331.0	I37.9	82.7	388.0	I000
4	Selenium mg/L	0.000	0.000	0.000	0.000	0.000	4.572	10.92 2	8.949	8.488	3.209	0.04
5	Aluminum mg/L	0.039	0.026	0.017	0.060	0.030	1.650	0,596	0.199	0.000	0.000	0.2
6	Arsenic mg/L	0.000	0.000	0.398	0.229	0.174	22.50	24.72	26.38	26.38	0.757	0.05
7	Manganese mg/L	0.981	6.936	32.891	0.973	0.074	0.221	0.300	2.059	0.062	10.97 0	0.02
8	Siliver mg/L	0.023	0.000	0.000	0.000	0.000	0.132	0.000	0.000	0.000	0.000	0.5
9	Copper mg/L	0.012	0.000	0.011	0.026	0.026	0.028	0.027	0.000	0.000	0.000	2
10	Mercury mg/L	0.000	0.000	0.000	0.000	0.000	0.481	0.188	0.101	0.212	0.315	0.01
11	Lead mg/L	0.292	0.000	0.000	0.000	0.000	0.000	0.444	2.728	0.907	1.288	0.01
12	Zinc mg/L	0.000	0.163	0.006	0.000	0.000	0.032	0.034	0.470	0.228	9.885	5.00
13	Cobalt mg/L	0.047	0.000	0.012	0.105	0.070	0.172	0.145	0.000	0.000	0.000	0.04
14	Nickel mg/L	0.000	0.000	0.021	0.027	0.032	0.059	0.108	0.000	0.000	0.149	0.02
15	Cadmium mg/L	0.055	0.047	0.039	0.098	0.084	1.459	0.736	0.618	0.359	2.170	0.003
16	Chromium mg/L	0.057	0.000	0.061	0.000	0.000	0.796	0.237	0.015	0.891	0.000	0.05
17	Iron mg/L	2.464	31.578	1.197	9.706	2.232	0.590	0.000	0.634	6.778	0.000	0.3
18	Molybdenum mg/L	0.122	0.153	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.07

DISCUSSION

Most recently, the term "heavy metal" has been used as a general term for those metals and semimetals with potential human or environmental toxicity (Ekpo, 1995). Some occur naturally in the environment and are essential while others are anthropogenetically generated. Several of them are useful to organisms for the maintenance of health and when a measurable deficit in the diet is allowed, the growth and vitality of humans, animals and plants is reduced to a certain degree. Thus, even wellknown toxic elements, such as As, Ag, Cd, Al, Pb, Cr, etc. are needed in minute quantities for the normal functioning of cell metabolism (Mertz and Coratzer 1971). Though, heavy metals are known to cause a wide range of adverse health effects because of the organic species and compounds emanate from it. Heavy metals and metalloids are not readily assimilated by living organisms. They are excreted very slowly and have the ability to accumulate in the body. Exposure to pollutant heavy elements can cause many ailments, including dermatitis, cardiovascular diseases, central nervous system (CNS) disorders, lung, kidney and liver damage, birth defects and cancer (Nriagu 1990).

IRON (Fe^{2+})

Iron in surface water is present as Fe^{2+} or Fe^{3+} in suspended form.

Most surface water contains some iron because it is common in many aquifers and it is found in trace amounts in practically all sediments and rock formations. It also comes into water not only natural geological sources, but industrial wastes, domestic discharge and from byproducts. Iron in suspended form, causes staining in clothes and imparts a bitter taste. Excess amount of iron (more than 10 mg/kg) causes rapid increase in pulse rate and coagulation of blood in blood vessels, hypertension and drowsiness.

The minimum and maximum concentrations of iron obtained from the surface water at the ten different water samples on Enyigba and its environs are shown in table 1 and figure 22. This ranged from 0.00 mg/L in the sample from Enyigba salt lake (SW8) and 31.578 mg/L in the sample from Ishiagu bus-stop (SW2). The maximum permissible limit by WHO is 0.3mg/L for iron. From the analyzed samples, two sample are free from iron concentration as seen in Enyigba salt lake (SW8) and Ameka stream(SW10) while the remain eight samples are of high value; and were highly above the maximum permissible limit set by the world health organization.(WHO) for drinking water. This indicates that the local mineral deposit (lead-zinc) in the study area have an effect on the surface water in the area.

ZINC (Zn^{2+})

Zinc is abundant in the earth's crust. It is a chalcophile metallic element and forms several minerals, including Sphalerite (ZnS), the commonest Zn mineral, Smithsonite ($ZnCO_3$) and Zincite (ZnO), but is also widely dispersed as a trace element in pyroxene, amphibole, mica, garnet and magnetite. The analysis for zinc in all the samples showed a very low concentration ranging from 0.00mg/L (in most places) to 9.885 mg/L. 5mg/L is the WHO permissible limit for zinc. The low concentration of zinc in the area is due to the high depth mineral which are not common to the surface water.

ARSENIC (As^{3+})

Arsenic is a key contaminant for many decades that occurs in a variety of minerals including Arseno pyrite (FeAsS), Realgar (As_2S_2), Orpiment ($As2S_3$), Arsenolite (As_4O_6), native Arsenic in ores of Copper, Lead, Cobalt, Nickel, Zinc, Silver, tin and also as nickel glance (NiAsS) or mispickel (Bello, 1996; Garba et al. 2008). Arsenic is chemically very similar to its predecessor phosphorus, so much that it will partly substitute for it in biochemical reactions and is thus poisonous. When heated it rapidly oxidizes to arsenous oxide, which has a garlic odour. Arsenic and some Arsenic compounds can also sublime upon heating, converting directly to a gaseous form.

Concentration of arsenic in water sample analyzed range from 0.00mg/L to 26.38 mg/L. But in samples SW1 and SW2 (see table 1 and figure 3) records free arsenic

concentration, while The rest of the arsenic in all the remaining samples, are of high value and above 0.05 mg/L which is the WHO maximum permissible limit. These values showing that Surface water in these locations are not good for human consumption because prolonged consumption of water with high concentration of arsenic could cause cancer of the skin, bladder and lungs (Goebel *et al,* 1990).The high concentration of arsenic in the area of study is as the proximity of the water samples to the lead-zinc mining vein. Exposure to inorganic arsenic can cause various health effects, such as irritation of the stomach and intestines, decrease production of red and white blood cells, skin changes and lung irritation. A very high exposure to inorganic arsenic can cause infertility and miscarriages with women, and it can cause skin disturbances, decline resistance to infections, hearth disruptions and brain damages with both women and men.
The concentrations of the dangerous inorganic arsenics that are currently present in surface waters enhances of alteration of genetic materials of fish. This is mainly caused by accumulation of arsenic in the bodies of plant–eating freshwater organisms. Birds eat the fish that already contain eminent amounts of arsenic and will die as a result of arsenic poisoning as the fish is decomposed in their bodies.

MANGANESE (Mn^{2+})

The concentration of Manganese obtained from the Surface waters in the area ranges from 0.062 mg/L to 32.891mg/L. The maximum permissible limit by WHO is 0.2 mg/L. This implies high Manganese in all the samples were observed to be above the maximum permissible limit set by the world health organization.(WHO 2008) for water or drinking water. These high concentrations are generated from the anthropogenic and mining activities obtainable on the study area.

SELENIUM (Se^{2+})

Selenium is a trace element that naturally present in many food, added to others, and available as a dietary supplementary. Selenium, which is nutritionally essential for humans, is a constituent for more than two dozen selenoprotein, thyroid hormone metabolism that play critical roles in reproduction, and protection from oxidative damage and infection. Selenium exist in two forms; inorganic (selenate and selenite) and organic (salenomethionine and selenocysteine), both can be good dietary sources of selenium. From all the water samples analyzed, none has any concentration of selenium. According to world health organization (WHO, 2008), the maximum permissible limit for selenium is 0.04mg/L which implies that selenium is high to SW6-SW10 while SW1- SW5 are free (Table1 and Figure 3) above.

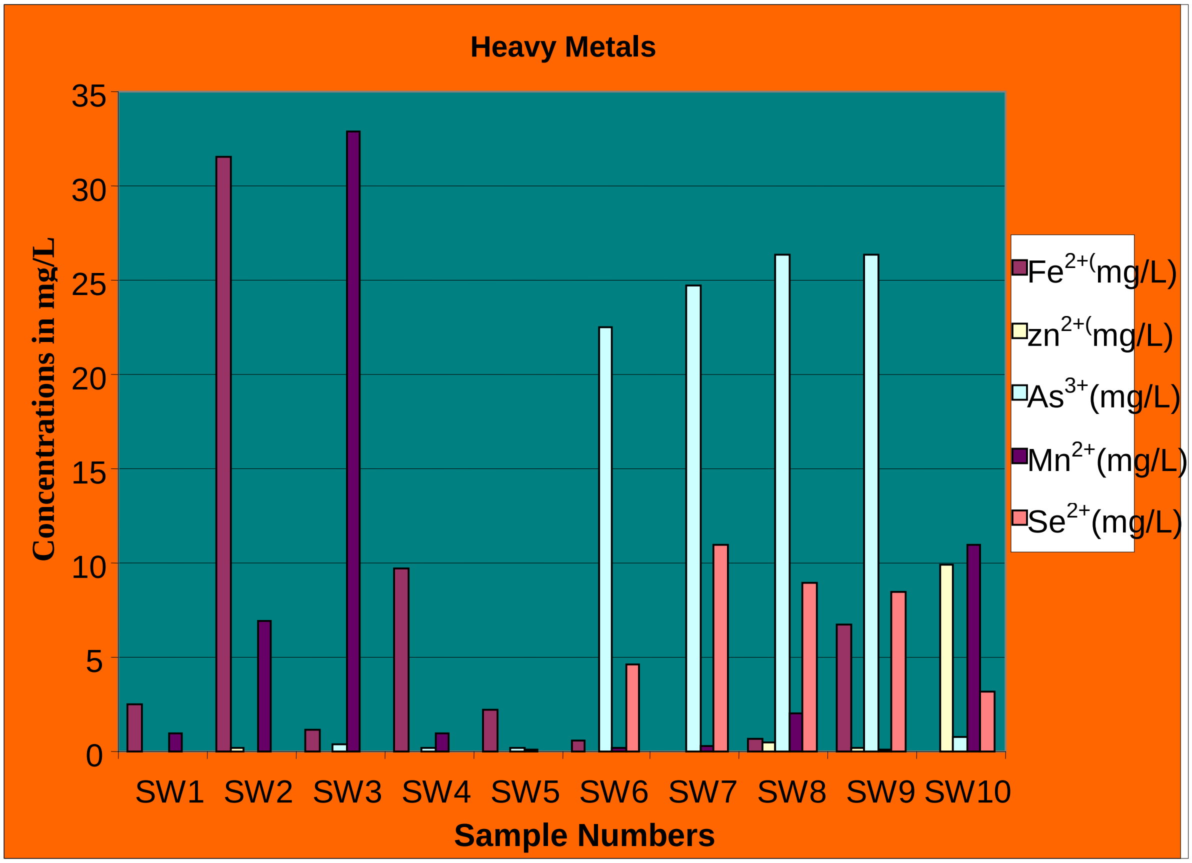

Figure 2: Concentrations of some heavy metals in Surface water.

ALUMINUM (Al^{3+})

Aluminum is ubiquitous in our environment; it is the third most prevalent element in the Earth's crust. It mainly forms during mineral weathering of feldspars, such as orthoclase, anorthite and albbite that are mostly released from acidic rain to the soil and thereby enter the surface water through run- off water. From the study area, aluminum concentrations vary from 0.00 mg/L to 1.65 mg/L (Table1). The high value of aluminum was observed at Akpara River (SW6) is 1.65 mg/L and Ngele River (SW7) is 0.596 (mg/L) and it was above the 0.2mg/L, WHO permissible limit for Aluminum. While the remaining eight was low and it implies the concentration Aluminum in most of the area are of low value.

MERCURY (Hg^{2+})

Mercury is natural occurring metallic element found in trace amount in air, water and soil. It is toxic to both aquifer life and human health concern. Inorganic mercury occurs naturally due to its presence in rock and soil, where it is slowly released through weathering and erosion to the surface water. Most of mercury in surface water remains inorganic, but in certain environment (low pH, low dissolved oxygen and high organic matter, such are found in bottom of lakes, mashes and wetlands). Some of it is covered with much more toxic organic from methylmercury (MeHg). Mercury also enters surface water through airborne, fired coal, and other industries sources can settle into the soil and river, lakes and ocean, where microbite convert it to methylmercury through a biochemical reaction.

From the samples analyzed the concentration of mercury ranges from 0.101mg/l to 0.481mg/l. It was also observed that samples around Enyigba had no concentration of mercury (Table 1 and Figure 3). According to world health organization (WHO), 2008 the maximum permissible limit for mercury is 0.01mg/L. This shows serious contamination in the Ameka area. Short-term exposure to high levels of metallic mercury vapors may cause lung damage, nausea, vomiting, diarrhoea, increases in blood pressure or heart rate, skin rashes, and eye irritation. Adrenal gland dysfunction, discouragement, dizziness, fatigue, headaches, hearing loss, loss of self-control, memory loss, mood swings, nervousness, numbness and tingling, pain in limbs, rashes, tremors, peripheral vision loss and muscle weakness are its long term effects

LEAD (Pb^{2+})

Lead is a chalcophile metallic element forming several important minerals including Galena (PbS), Angeesite ($PbSO_4$), Cerussite ($PbCO_3$) and Minium ($Pb3O_4$). It is also widely dispersed at trace levels in a range of other minerals, including K-feldspar, plagioclase, mica, zircon and magnetite. It is one of the seven metals known in antiquity, because of its relative ease of extraction as a metal. From the ten samples analyzed, the concentration of lead ranges from 0.00mg/l in most places to 2.728mg/l (ie the Enyigba Salt lake. This implies that the salt lake is also sitting on a mineralized vein, which introduces these high concentrations. The Ameka pond and stream also recorded high concentration of lead. The maximum limits for lead metals according to World Health Organization (WHO,2008) is 0.01mg/L. Lead accumulates in the bodies of water organisms and soil organisms and causes health effects from lead poisoning. Health effects on shellfish can take place even when only very small concentrations of lead are present. Body functions of phytoplankton can be disturbed when lead interfers. Phytoplankton is an important source of oxygen production in seas and many larger sea – animals eat it. Lead is particularly dangerous as it can accumulate in individual organisms, and also in entire food chains. In humans, lead can cause various damages which may include the following: Disruption of the biosynthesis of haemoglobin and anaemia, rise in blood pressure, kidney damage, miscarriages and subtle abortions, disruption of nervous systems, brain damage, and decline fertility in men through sperm damage and diminished learning abilities of children.

CADMIUM (Cd^{2+})

Cadmium occurs in minor concentration in water. It always occurs in combination with zinc. It is also found in secondary minerals such as hawleyite and greenockite. Cadmium also consists in the industries as an inevitable by product of zinc, lead, and copper extraction. After being applied it enters the environment mainly through the ground, because it is found in manures and pesticides. Cadmium was found in all the analyzed samples, its concentration ranges from 0.039mg/L as minimum and 0.098 mg/L as the maximum with the mean value of 0.065 (see table1). From all the samples analyzed, the concentration of cadmium was above 0.003mg/L the WHO maximum permissible limits. Cadmium is high which indicating high contributions from the dissolution of ore minerals (lead-zinc)

CHROMIUM (Cr^{3+})

Chromium is also essential for organism as a micronutrient in traces from fat and carbohydrate metabolism. Chromium is also more harmful in its lower oxidation state (III). Chromium value of 0.061mg and chromates are potential carcinogens. The concentration of chromium in Enyigba and its environs varies from 0.00mg/L as the minimum and 0.891 as the maximum. From the ten samples analyzed, only two samples found beside Friday Oketa compound (SW1) and that of Enyigba tunnel with other four samples, have chromium which are high. While the other three water samples of SW2, SW4 and SW5 and SW10 are free (see table1 and figure 4). According to world health organization (WHO), 2008 the maximum permissible limit of chromium in water is 0.005mg/L. The high concentration of chromium is due to the high rate of mining activities present in the area.

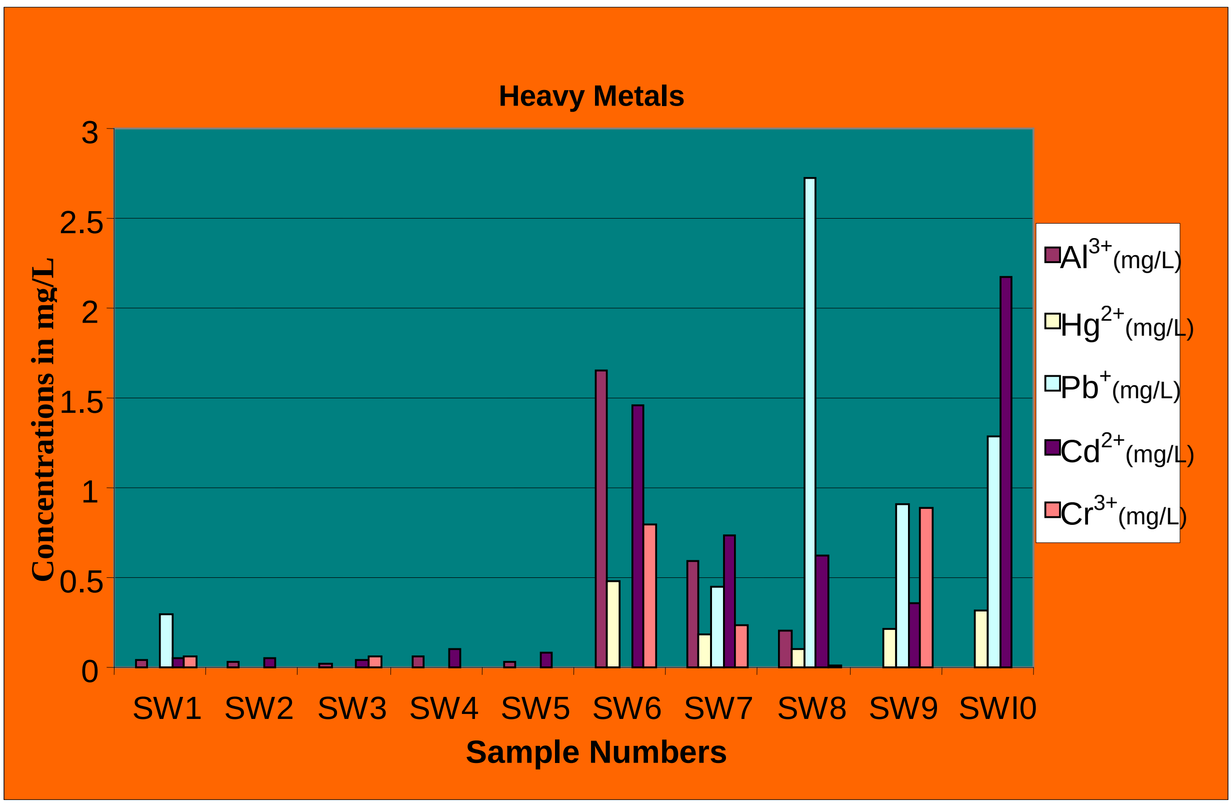

Figure 3: Concentrations of some heavy metals in Surface water analysed.

MOLYBDENUM Mo^{2+}

Molybdenum compounds are present in lubricants, printing inks, paints, rubbers, leathers, and fertilizers, and are also used extensively in the petroleum industry (Stokinger 1981). Natural sources of molybdenum to the aquatic environment include the weathering of ores from igneous and sedimentary rock (especially shale) and subsequent runoff to streams and lakes. Molybdenum may also enter the aquatic environment through leaching processes near molybdenum mines and burning of fossil fuels.

From the ten water samples analysed, from the study area, only two samples showed concentrations of molybdenum (ie samples from Ishiagu, Enyigba 0.122mg/l and 0.153mg/l). The WHO permissible limit for molybdenum in water is 0.07mg/L. This implies high concentration of molybdenum in the Ishiagu area of Enyigba. Molybdenum causes crohn disease. Urinary levels of molybdenum and copper and serum levels of uric acid and ceruloplasmin appeared to be affected by molybdenum levels in drinking-water (Abumrad et al., 1981).

COBALT (Co^+)

Cobalt is a naturally occurring element, which can be found in various forms in ambient air, soil, surface water, ground water and sediment. Cobalt is an essential micro nutrient required for the formation of vitamin B_{12} and for its function in enzymatic process. Anthropogenic source of cobalt to the environment include; burning of fossil fuel, sewages sledge, phosphate fertilizer, mining ore and industrial processes. These processes are been discharge to the surface water especially cobalt chloride ($CoCl_2$), cobalt sulphate ($Co.H_2So_4$) and elemental cobalt (Co), which are highly soluble and always releases ions in solution.

From the study area, the cobalt concentration ranges from 0.00mg/L to 0.172mg/L as the minimum and maximum respectively. (Table 1 and Figure 4). From the ten water samples analyzed, its value recoded most on Akpara River (SW6) 0.172mg/L and Ngele River (SW7) 0.145mg/L respectively. But according to the world health organization (WHO), 2008 cobalt has 0.04mg/L as the maximum permissible limit. This implies that cobalt is high, which indicating the high contributions from the dissolution of ore minerals and the proximity mining sites.

Nickel (Ni^{2+})

Nickel is a trace element. Its concentration ranges from 0.00mg/L to 0.149mg/L. The maximum permissible limit for nickel is 0.02 mg/L. This implies high concentration of nickel in some areas, especially in the Akpara, Nwakpu and Ngele Rivers, Ameka stream. This high concentration is because these rivers are receptacles of mine waters pumped out of the mine pits.

Uptake of large quantity of nickel can lead to higher chances of development of lung cancer, nose cancer, larynx cancer and prostate cancer. Birth defects (depression, heart attacks), vomiting, Asthma and chronic bronchitis have all been related to high nickel concentrations.

SILVER (Ag^+)

Silver is present in silver compounds primarily in the oxidation state +1 and less frequently in the oxidation state +2. A higher degree of oxidation is very rare. The most important silver compounds from the point of view of surface water are silver nitrate ($AgNO_3$), and silver chloride (AgCl). From the analysis, the concentration of silver was observed only in samples SW_1, (Beside Friday Oketa compound, 0.023mg/l) and sample SW_6 (Akpara River, 0.132mg/l), the other samples are free from silver concentration (table 1). The maximum acceptable limit for Silver by World Health Organization is 0.5 mg/L. This indicates no contamination for silver in the area.

COPPER (Cu^{2+})

The copper levels were found in the range 0.00mg/L to 0.028 mg/L as the minimum and maximum respectively. The maximum permissible limit concentration of copper in water is 2 mg/L according to (WHO) 2008. The value of copper content was found in four samples out of five. Meaning that the Water samples of Enyigba and it environs is good and free from high copper concentration and this indicating low contributions from the dissolution of ore minerals. Though Copper is an essential nutrient, but at high doses it has been shown to cause stomach and intestinal distress, liver, kidney damage, and anemia (US EPA, 2003).

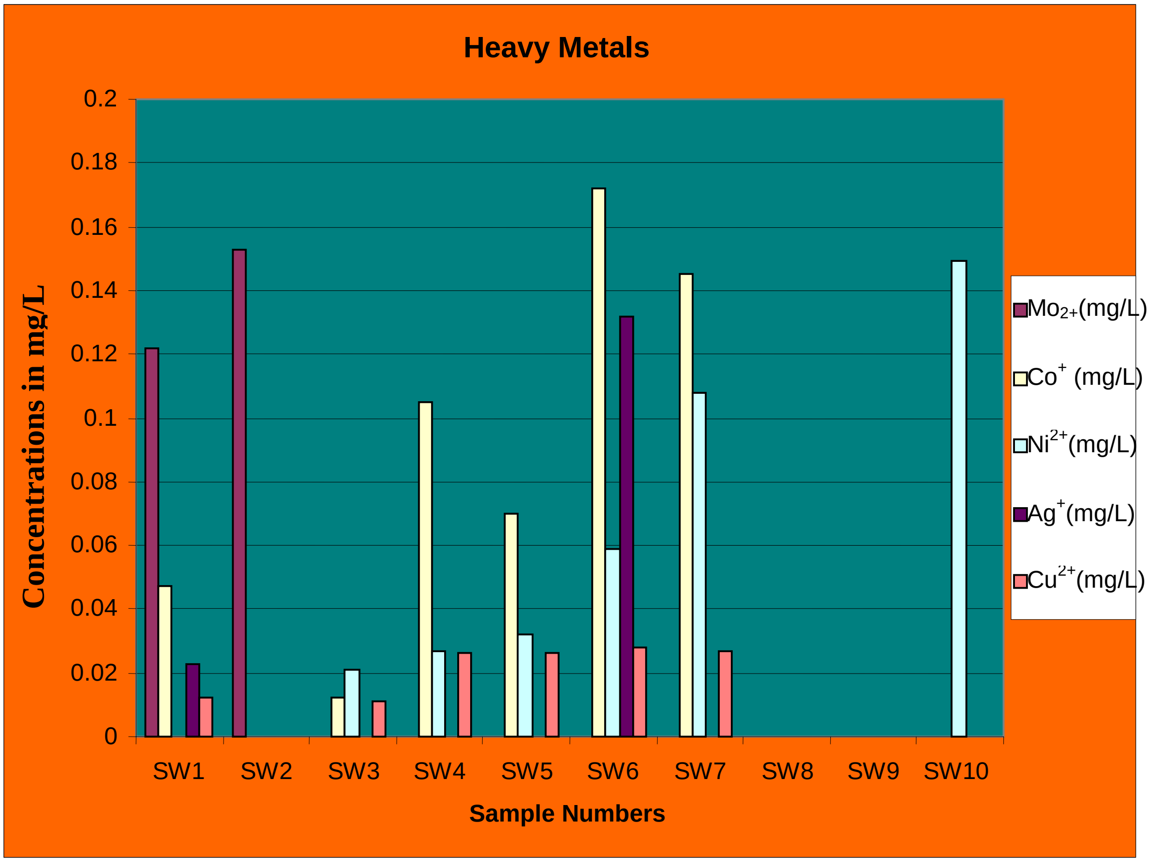

Figure 4: Concentrations of some heavy metals in Surface water analysed.

4.2 EFFECT OF HEAVY METALS ON PLANTS, ANIMALS AND HUMAN.

Selenium

Selenium is toxic in large amounts, but trace amounts of it are necessary for cellular function. Short-term oral exposure to high concentrations can cause nausea, vomiting, and diarrhea. Major signs of selenosis are hair loss, nail brittle-ness, and neurological abnormalities. Brief exposures to high levels in air can result in respiratory tract irritation, bronchitis, difficulty breathing, and stomach pains. Longer- term exposure can cause respiratory irritation, bronchial spasms, and coughing.

Chromium

Chromium (VI) compounds are toxics and known human carcinogens, whereas chromium (III) is an essential element. Breathing high levels can cause irritation to the lining of the nose; nose ulcers; running nose; and breathing problems, such as asthma, cough, shortness of breath, or wheezing. Long term exposure can cause damage to liver, kidney, circulatory and nerve disorders, as well as skin irritation

Cadmium

Human uptake of cadmium takes place mainly through food. Foodstuffs that are rich in cadmium can greatly increase the cadmium concentration in human bodies. Examples are liver, mushrooms, shellfish, mussels, cocoa powder, and dried seaward. Other health effects that can be caused by cadmium are:

- Diarrhea, stomach pains and severe vomiting.
- Bone fracture.
- Reproductive failure and possibly even infertility.
- Damage to the central nervous system.
- Damage to the immune system.
- Psychological disorders.
- Possibly DNA damage or cancer development.

Copper

Long term exposure to copper can cause irritation of the nose, mouth and eyes and it causes headaches, stomachaches, dizziness, vomiting and diarrhea. Intentionally high intake of copper may cause liver and kidney damage and even death. Whether copper is carcinogenic has not been determined yet. When copper ends up in soil it strongly attaches to organic matter and minerals. As a result it does not travel very far after release and it hardly ever enters groundwater. In surface water copper can travel great distance, either suspended on sludge particles or as free ions. Copper does not break down in the environment and because of that it can accumulate in plants and animals when it is found in soils. On – rich soils only a limited number of plants have a chance of survival.

Zinc

Zinc occurs naturally in air, water and soil, but zinc concentrations are rising unnaturally, due to addition of zinc through human activities. Most zinc is added during industrial activities, such as mining, coal and waste combustion and steel processing. Some soils are heavily contaminated with zinc, and these are to be found in areas where zinc has to be mined or refined, or were sewage sludge from industrial areas has been used as fertilizer. Zinc been a trace element, is essential for human health. When people absorbs too little zinc they can experience a loss of appetite, decreased sense of taste and smell, slow wound healing skin sores. Zinc – shortages can cause birth defects. Zinc can still cause eminent health problems, such as stomach cramps, skin irritations, vomiting, nausea and anaemia. Very high levels of zinc can damage the pancreas and disturb the protein metabolism, and cause arteriosclerosis. Extensive exposure to zinc chloride can cause respiratory disorders.

Silver

Silver Exposure to high levels for a long period may result in a condition called argyria, a blue-gray discoloration of the skin and other body tissues, which appears to be a cosmetic problem that may not be otherwise harmful to health. Exposure to high levels of silver in the air can result in breathing problems, lung and throat irritation and stomach pains. Skin contact with silver can cause mild allergic reactions such as rash, swelling, and inflammation.

Aluminum

Aluminum can be toxic at higher level; it is considerably less toxic than either mercury or lead. In fact, aluminum is found at easily measurable levels in various biological fluids and tissues. However, at high levels aluminum has the potential to cause a number of health problems such as anaemia and other blood disorders, colic, fatigue, dental caries, dementia dialectic, kidney and liver

Mercury

Mercury combines with other elements to form organic and inorganic mercury compounds. Dysfunctions, neuromuscular disorders, osteomalacia and Parkinson's disease (idiopathic)

5.0 Conclusion

Hydrochemical Analysis of water sample of Enyigba was carried out using Atomic Absorption Spectrometers (Varian 240 AAS). From the results, concentration of Physical parameters like pH, electrical conductivity, turbidity, and TDS reveal that the water resources are slightly acidic to basic in most places. The turbidity and pH are far above the WHO recommended standard for drinking water, while electrical conductivity and TDS are below. The high concentration of turbidity, indicate the rate of organic matter decaying in the water. There is high concentration of Fe^{2+} (0.000-31.578mg/L), Al^{3+} (0.00-1.65mg/L), As^{3+} (0.00-26.38mg/L), Cr^{3+} (0.00-0.891mg/L), Mn^{2+} (0.062-32.891mg/L), Ni^{2+} (0.00-0.149mg/L), Cd^{2+} (0.039-2.170mg/L), Mo^{2+} (0.00-0.153mg/L), Co^{+} (0.00-0.172mg/L), Pb^{2+} (0.00-2.728mg/L), Zn^{2+} (0.00-9.885mg/L), Se^{2+}(0.00-10.922mg/L) and Hg^{2+} (0.00-0.481mg/L) are of high concentrations, and Ag^{+} and Cu^{2+} has low concentrations. Based on WHO recommended limit, these high and low may be attributed to the dissolution of ore minerals which is not static in the area. The nature of lead-zinc vein that filled Enyigba and its environs has affected most of the water samples of the area.

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