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ATOMIC ABSORPTION SPECTROSCOPY ANALYSIS OF HEAVY METALS IN WATER AT MAI-GANGA COAL MINING VILLAGE, GOMBE STATE, NIGERIA

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ABSTRACT
This study was designed to detect heavy metals level in water collected from Mai-ganga Coal mining village, Gombe State, North-East Nigeria. Samples was analyzed using Atomic Absorption Spectroscopy. The level of Pb, Ni, Cd, Co, Cu, Mn, Mg, Zn, and Fe were assessed. The result shows significant level of Pb at 1.833 mg/l and 5mg/l for Fe which exceeded the WHO limit (0.01 mg/l). Cu, Cr, Zn, Mn, and mg found at 0.2193, 0.4285, 0.5294, 1.60, and 3.50 mg/l respectively. Cd, and Ni were detected at 0.001mg/l and 0.002 mg/l respectively. Co was only detected in surface water (Mai-ganga earth dam) in all the samples collected. Cd, Mg, Ni, and Zn were found below the WHO, USEPA limits. Pb, Fe were found to exceed the recommended limits. Therefore, this study seeks to enlighten the mining community about the risk of heavy metals and the need by the government/mining industries to provide alternatives for Mai-ganga drinking water.

Keywords: Borehole, Earth dam, World Health Organization, Drinking water, Mai-ganga Village

INTRODUCTION

Atomic Absorption Spectrometry (AAS) is a technique for measuring quantities of chemical elements present in environmental samples by measuring the absorbed radiation by the chemical element of interest. This is done by reading the spectra produced when the sample is excited by radiation. A detector measures the wavelengths of light transmitted by the sample, and compares them to the wavelengths which originally passed through the sample. A signal processor then integrates the changes in wavelength absorbed, which appear in the readout as peaks of energy absorption at discrete wavelengths. The energy required for an electron to leave an atom is known as ionization energy and is specific to each chemical element (Gracier & Baez, 2013). When an electron moves from one energy level to another within the atom, a photon is emitted with energy **E**. Atoms of an element emit a characteristic spectral line (Filov, 1988).

Heavy metals were literally heaven's sent by originating from asteroid impacts. Typically, heavy metals occur in the earth's crust in rather low concentrations between the low ppb ranges (noble metals) and up to 5% (iron); here, heavy metals are mainly found chemically bound in carbonate, sulfate, oxide, or silicate rocks or also occur in their metallic, elemental form (Duffus, 2002). Weathering and erosion resulted in their leaching and mitigation into soil, rivers, and groundwater. About 4–5 billions of years ago, when Earth's mantle was still liquid, heavy metals sank to Earth's center and formed Earth's core, which today predominately consists of the heavy metals iron and nickel (Mertz, 1981). Heavy metals are usually present in traced amounts in natural water sources such as ponds, lakes along with underground water sources. Some of the heavy metal ions are very toxic even at low concentration for human beings. Heavy metals are widespread pollutants of water. They originate primarily from industrialized regions where streams and rivers flow. Micro-concentrations of heavy metals in water influence harmfully on the environment gradually by the time they accumulate in certain parts of the animal and plant organism, causing the change in their biochemical balances. Therefore, accurate information about the presence of heavy metals in seawater is of great biological and environmental significance (Stowers, Cox & Rodiguez, 2014). Metals which are reported to be having an adverse effect on human beings are arsenic, lead, cadmium, nickel, mercury, chromium, copper, zinc, and selenium. These metal ions are increasing day by day in the natural resources as currently numbers of industrial complexes are increasing near human population in cities with a goal of improving the quality of human life. Some heavy metals like copper, selenium, or zinc are essential trace elements, with functions indispensable for various biological processes also driving the entire human metabolism (Terfassa, Schachner, Traar, Belaj & Zanetti, 2014). The heavy metal cobalt, acting as the central atom in the vitamin B12 complex, is a key player in the reductive branch of the propionic acid fermentation pathway (Kislaya, 2013). Many heavy metals are of outstanding technological significance, e.g., iron, zinc, tin, lead, copper, tungsten, etc. Recently, different heavy metals act as the central atom of artificially designed "bioinorganic" catalysts for special chemical transformations (Chasten, 2000). Moreover, among them we find precious noble elements like gold, silver, iridium, rhodium, or platinum. On the other hand, many of the heavy metals, e.g., mercury, cadmium, arsenic, chromium, thallium, lead, and others, classically represent the "dark side of chemistry"; they exert toxic effects already at low concentration (Orosun *et al* 2016).

MATERIALS AND METHODS

Study Area

The study area, Mai-ganga coal mining village is located in Gombe State, an 8km drive off Gombe-Yola road. Mai-ganga is located west of Kumo town covering about 20,129.47 Acres (48.16km2) at a Latitude $09^0$18 and $11^0$59E.

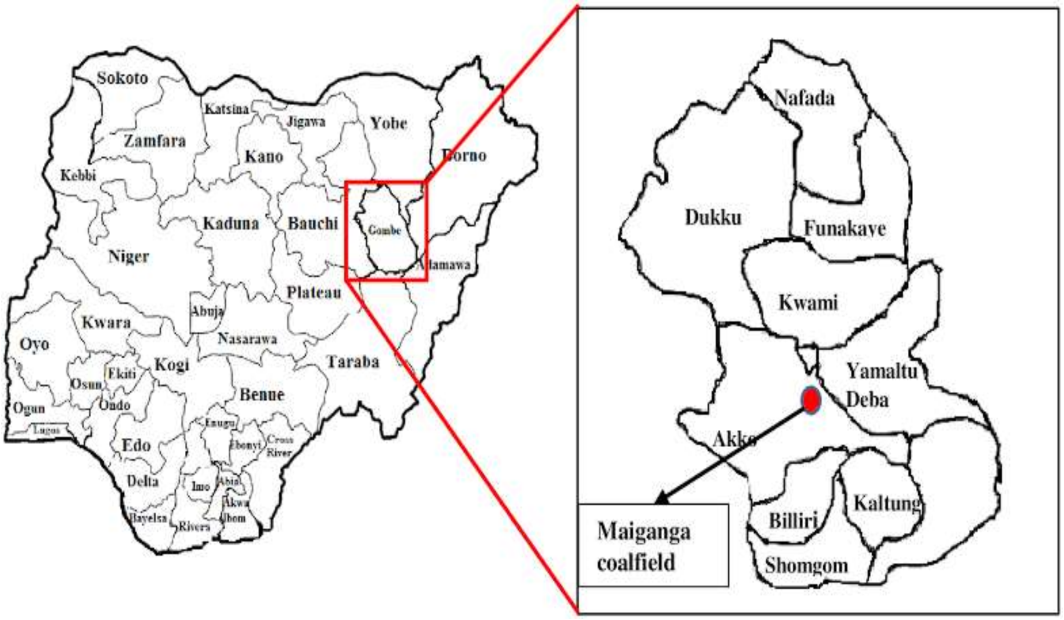

Fig 1: Map of Nigeria showing the study area

Water Sample collection
The water sample were collected in the month of June, 2019 from five different boreholes. i.e Sample 1: Maiganga west Sample 2: Mai-ganga east Sample 3: Mai-ganga south Sample 4: Maiganga East Dam (Tudun kuka). The water samples were collected in a clean polyethylene bottles, because glass bottles absorb metals and therefore will cause inaccuracy in analysis.

Sample Preparation
Sample preparation is often simple, and the chemical form of the element is usually unimportant. This is because atomization converts the sample into free atoms irrespective of its initial state (Kislaya, 2013). The sample is weighed and made into a solution by suitable dilution. For the digestion, 1L of each sample was measured into a clean digestion flask. 9ml of concentrated HNO_3 and 3ml of concentrated HCl was added into the sample in the digestion flask. The whole sample was heated in a hot plate until all the brownish fumes was expelled out (Nitrogenous Compound) which confirm that the sample is digested and the samples was allowed to cool at room temperature. A few milliliters of distilled water was added and the mixture was filtered into 25ml standard flask and it was transferred into plastic reagent bottle for Atomic Absorption Spectrometry (AAS).

Sample Characterization
The water sample collected from the study area was characterized using Atomic Absorption Spectroscopy. The trace amount of heavy metals was obtained using Atomic Absorption Spectrometer (AAS Buck Scientific 205) in the Department of Biochemistry, Gombe State University, Nigeria and (AAS Buck Scientific VGP210) in the Department of Geography, Bayero University, Kano, Nigeria.

RESULTS AND DISCUSSION
The water samples collected from boreholes and local earth dam sources were studied and analyzed for heavy metals using AAS.

RESULTS
The table below shows the result obtained from the heavy metals analysis in mg/l

	Cr	Mn	Cu	Zn	Fe	Pb	Mg
MGE	0.422	1.6	0.2193	0.5294	5	1.833	4.39
MGN	0.581	3.21	0.2297	0.4295	4.198	1.6217	3.16
MGW	0.301	2.7	0.1872	0.5002	3.755	1.3121	5.91
MGS	0.501	2.56	0.3101	0.4101	4.2131	1.822	4.02
MGD	0.211	1.123	0.1921	0.3781	2.7877	1.1374	6.4

MGE= Mai-ganga East
MGN= Mai-ganga North
MGW= Mai-ganga West
MGS= Mai-ganga South
MGD= Mai-ganga Dam

Fig. 2 below shows the measured concentration of the heavy metals traced in the collected water samples in mg/l. the plot of figure 2 was obtained from the result of study in table 1 above.

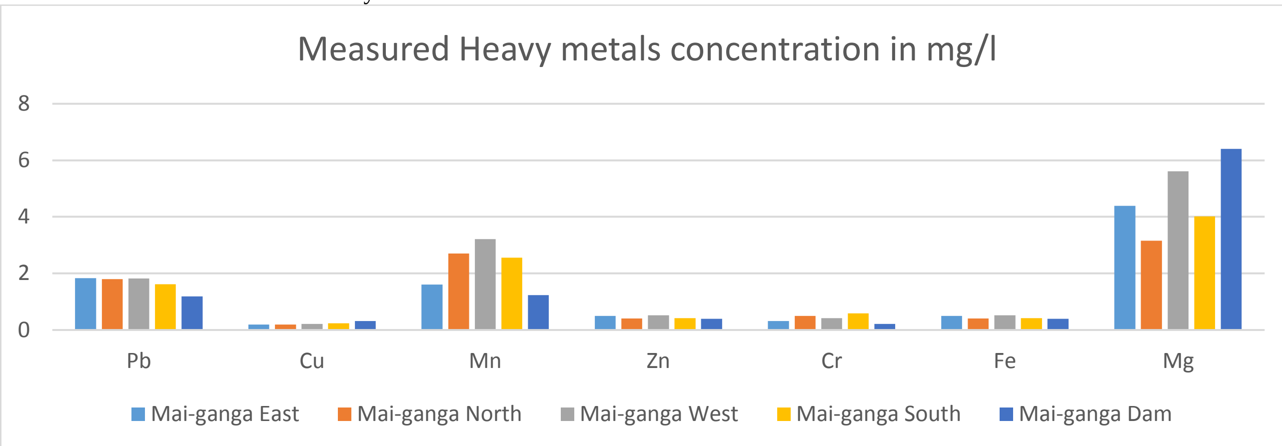

Fig 2: Plot of heavy metals level in water sample

Comparison of Results obtained with other studies.
The result obtained from the analysis of heavy metals in the water sample from Maiganga coal mining village, Gombe State was compared with other studies.
Table 2 (Shitu, Chifu, Hafeez & Sulaiman, 2016) shows the Maximum Contamination Level (MCL) of some heavy metals in drinking water set by different organizations such as Nigerian Standards for Drinking Water Quality (NSDWQ), National Agency for Food and Drug Administration and Control (NAFDAC), United States Environmental Protection Agency (USEPA) and World Health Organization (WHO).

Table 2: Maximum permissible limit of Heavy metals in mg/l

	Cd	Co	Cu	Pb	Fe	Mn	Mg	Hg	Ni	Zn
NSDWQ	0.003	NM	1.0	0.01	0.3	0.2	20	0.001	0.02	3.0
NAFDAC	0.0	NM	1.0	0.0	0.3	0.2	20	0.0	0.02	3.0
USEPA	0.005	0.1	1.3	0.015	0.3	0.05	NM	0.002	0.1	0.500
WHO	0.003	NM	2.0	0.01	0.3	0.4	NM	0.01	0.07	5.0

NM= Not mentioned

Table 3: Comparison of measured heavy elements in Maiganga coal mining village water with other studies.

Elements	Dutse	Abakaliki	Ibadan	Pakistan	Gombe	Maiganga
Cd	0.003	0.012	0.008	0.067	-	0.001
Mn	0.273	-	-	-	0.12	1.60
Cu	-	0.023	-	-	0.02	0.2193
Fe	1.824	-	0.530	1.676	0.62	5
Zn	-	-	0.040	-	-	0.5294
Pb	-	0.077	0.190	0.351	-	1.8333
Ni	0.043	-	-	0.004	-	0.002

Table 3 shows the comparison between the measured heavy metals in Maiganga village with other places such as Dutse, Ibadan, Gombe, Abakaliki, and Pakistan.

DISCUSSION
Current drinking water quality guidelines (in ppm or mg/L) for the selected heavy metals published by several organizations, committees or agencies throughout the world are given in Table2. Table 3 give a comparative chart for the results obtained with other analysis.
For Cr within the study area the mean concentrations are 0.34642 mg/l. These values exceed the WHO permitted limit in drinking water. It has been reported that long term exposure to Cr can cause damage to liver, kidney circulatory and nerve tissues, as well as skin irritation (FEPA, 2017). For Zinc, Zn within the study area, the mean concentrations for both the borehole as well as the earth dam water are recorded below the maximum permissible limit set by both national and international bodies. The permissible limit of zinc in water according to WHO standards is 5 mg/l. In all the collected water samples concentration of zinc was recorded below the permissible limit.
It was observed that the Lead, Pb measured in Maiganga was greater than that of Dutse, Pishin-Pakistan and Gombe towns. The measured copper was greater than those of Gombe, Abakaliki and Dutse. Iron, Fe concentration in Maiganga was greater than those of all other locations in comparison. The concentration measured for Manganese in Maiganga was

greater than those of Dutse and Gombe. Moreover, Iron, Fe and Lead, Pb concentration in Maiganga was extremely high and exceeded all the guidelines recommended by National and International organizations including WHO and NSDWQ.

CONCLUSIONS

The result of the study shows that the concentration of the metals determined decreases in the order Fe > Pb > Mn > Zn > Cu > Ni > Cd. The concentrations within the study area are much higher than the concentrations compared with other studies of different areas. This implies that the concentration of these selected heavy metals is enhanced by the mining activities.

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