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# Analysis of Some Heavy Metals Concentration Levels from Groundwater Sources inLead mine Affected Areas of Anka, Zamfara State,Nigeria.

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***Abstract:*** *Heavy metal pollution status of groundwater in lead mine affected areas of Anka local government in Zamfara State was determined during peak dry season and peak rainy season. A total of 30 ground water samples from boreholes and hand dug wells were collected and analyzed using atomic absorption spectrophotometer (AAS 210VGP Model). The concentration levelsof chromium ion in boreholes and hand dug well water samples in peak dry season ranged from 0.073mg/l to 0.078mg/l, while 0.039mg/l to 0.048mg/l was recorded during peak rainy season. Lead ion concentration level ranged from 0.040mg/l to 0.043mg/l. The recorded values of chromium and lead ions were alarmingly higher than the permissible values of 0.05mg/l standard set by WHO and NESREA, 2011. The concentration levels of Copper, Nickel and Zinc in boreholes and hand dug wells both in peak dry and rainy season are below the stated standards. Thepresence of chromium and lead ions in both borehole and hand dug well water might be unhealthy for consumers of these sources of water in the long run.Adequate preventive measures/ regular monitoring of the water quality should be adopted to control the contamination of excess lead present in the water samples is recommendedfor lead mine affected areas.*

***Keywords:****Anka,Groundwater,Lead, Chromium,pollution,lead mine.*

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## I. Introduction

Ground water is required by all living things for cell metabolism. Water is also a vital resource for agriculture,manufacturing, transportation and many other human activities. Despite its importance, water is the most poorlymanaged resource in the world. Groundwater is the water that percolates downward from the surface through thesoil pores. Ground water is generally an excellent source of drinking, cleaning, bathing, irrigation and industrialpurposes Javed *et al*, (2006). The heavy metals are present in both surface water and ground water. Heavy metals are importantenvironmental pollutants and their toxicity is a problem of increasing significance for ecological, evolutionary andenvironmental reasons Nagajyoti*et al* (2008). Heavy metals arise from unorganized industrial growth and are considered as majorpollutants of natural water bodies. Anthropogenic activities like industrial production unsafe disposal of mining/industrialwastes, agricultural wastes and domestic sewages release heavy metals into the environment. Once released in largeamounts, they are soluble in water either as ions or as compound forms and thus contaminate water. Heavy metalsare playing a vital role in the normal functioning of body. But if excess than the permissible limit may harmsthe vital function of the organs. The main source for the heavy metal entry in to the human body is through waterresources. Illegal miners from different villages around Anka local government area in Zamfara state, brought rocks containing ore bearing heavy metals into their villages for small-scale mining operations; however, the villagers did not know the ore contained extremely high level of heavy metals. The ore were wash inside the village compounds spreading heavy metals waste (residues) on the surface of the soil, which infiltrate/percolate down the soil and contaminate the groundwater sources. As a result of this, the people ignorantly consumed or drunk the contaminated water containing the heavy metals from hand dug wells and boreholes in their communities, which in turn affects their health conditions. This therefore, called for the need to study the effects of exposure to such heavy metals (chromium, copper, lead, nickel and zinc) and to suggest possible solutions to the poisoning crises in themining area(Figure 1.1).

**Fig.1.1 Washing Activity of Heavy Metal in Bagega Village in Anka, Zamfara State**

## II. Description of the Study Area

Anka is one of the 14 Local Governments of Zamfara State. It is located between latitudes 11039'N and 12018'N, and longitudes 5054'E and 6019'E. With an area of 2,940km2, Anka has a population of 263,400 (National Population Commission, 2006, cited in Blacksmith Institute, 2011**).**Lead-zinc occurrence/mineralization in Anka is often associated with minor to significant amounts ofcopper and gold (Ministry of Mines and Steel Development, 2010).Lead (Pb) mineralization in Anka Zamfara State occurs in veins and as stringers in wall rocks,in a variety of rocks like quartz-schist's, and quartzitic-phyllitic schist's within the N-S trending Anka schist belt.The climate of Anka is warm tropical with temperatures rising up to 38$^{o}$C betweenMarch and May each year. Rainy season starts in late May to September while the dry season known as harmattan lasts fromDecember to February. There are two major soil types, ferruginous tropical soils and lithosols soils which dominate the local governmentGauje.et al, (2012). The vegetation of the area consists of northern Guinea Savannah which is characterized by short and stringyshrubs as indicated in Figure 2.

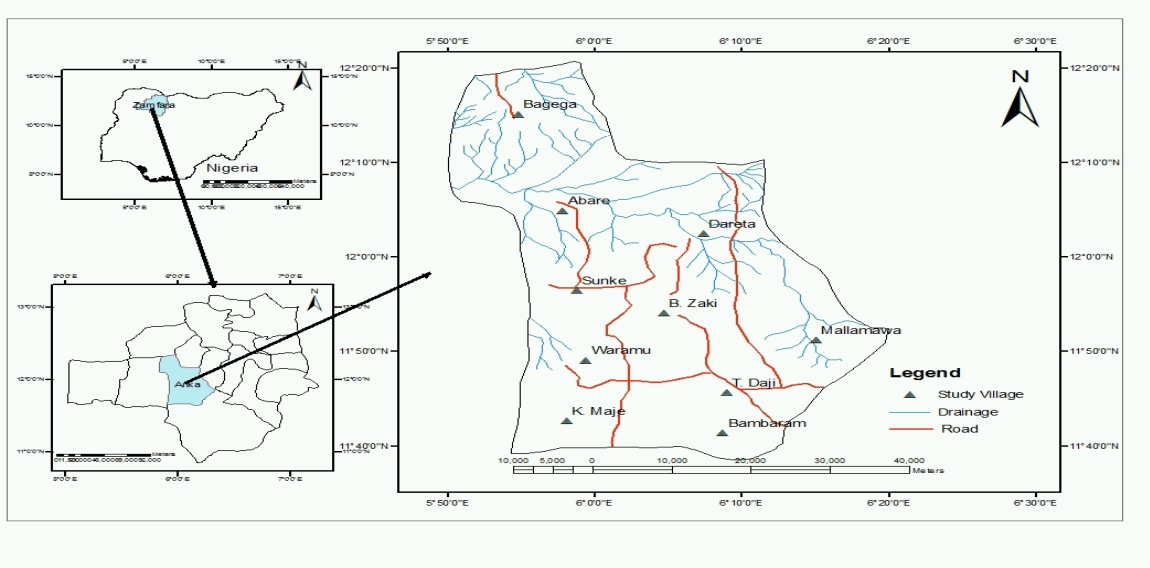


Figure 2: Map of Anka showing sampling points of groundwater in borehole and hand dug wells

## III. Materials And Methods

**Water sampling techniques and preservation**

Field work began immediately after the identification of thirty sampling points in ten villages in the study area during peak dry and rainy seasons (April and August 2017) respectively.Glass wares, polyethylene bottles, distilled water, concentrated HCl acid, beakers, hot plate, filter paper, volumetric flask, bucket, rope and clock watch were used throughout the experiment.

Groundwater samples from borehole and hand-dug well were collected in April and August, 2017 which were the peak periods during dry and rainy seasons in accordance with standard procedures by (APHA, 1998) from the study area. 15 water samples each were collected from different boreholes and hand dug wells in various villages. This gave a total of 30 water samples all within the study area in Anka LGA, Zamfara state, Nigeria. The samples were collected in pre-cleaned one litter polyethylene plastic bottles and acidified with concentrated hydrochloric acid (HCl) to less than PH 2.0 and respectively labeled. Similarly, water samples from boreholes were also obtained directly from the water pump and each sample bottle with it cap was rinsed three times with the water sample. These water samples were subsequently stored at $4^{o}C$ for a short time as possible before laboratory analysis to minimize physio-chemical changes (Anonymous, 1996), thereafter, the samples were transported to the laboratory in soil science department, Bayero university Kano, Nigeria for further analysis of the parameters Chromium, Copper, Nickel, Lead and Zinc respectively.

**Digestion of watersamples**

100ml of well mixed acid preserved water sample was transferred into a beaker and 5ml of concentrated HCl was added. The beaker was placed on a hot plate and allowed to evaporate to about 5ml without boiling, the sample was then allowed to cool before it was filtered through what man No. 4 filter paper. It was then diluted up to 100ml with distilled water in a volumetric flask which was then used in Atomic Absorption Spectrophotometer machine for analysis of the heavy metals involved.

**Water sampleanalysis**

After digestion of the water samples, heavy metals of interest were assayed in the water sample using AAS 210GP in the laboratory. Volume of 25ml of the prepared sample was aspirated into the electro-thermal device (Nebulizer – spray chamber) of AAS 210VGP machine where it was vaporized and atomized. Ratio of the proper wavelength is then pass through the vapor containing the ground state atoms of the metal where absorption occurs. The magnitude of the AAS absorption signal is directly proportional to the concentration of the analyte metal in the sample solution. This procedure were adopted for all the water sample (Nouri et al, 2006).The data obtained from laboratory analysis of the heavy metals were compared with one way analysis of variance (ANOVA) statistical package. The mean concentration values obtained for chromium, copper, nickel, lead and Zinc for borehole and hand dug well water samples are presented in the table below**:**

## IV. RESULTSAND DISCUSSIONS

**Table 1: Heavy Metal Concentration level in Boreholes and Hand dug Wells in Anka, Zamfara state**

| Seasonal Variation | BOREHOLES | | | | | HAND DUG WELLS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Cr mg/l | Cu mg/l | Ni mg/l | Pb mg/l | Zn mg/l | Cr mg/l | Cu mg/l | Ni mg/l | Pb mg/l | Zn mg/l |
| **Peak dry Season** | 0.073 | 0.026 | 0.060 | 0.040 | 0.071 | 0.078 | 0.277 | 0.066 | 0.043 | 0.078 |
| **Peak rainy season** | 0.039 | 0.170 | 0.041 | 0.022 | 0.055 | 0.048 | 0.199 | 0.045 | 0.023 | 0.057 |
| **WHO, 2011** | 0.05 | 2.0 | 0.07 | 0.01 | 5.0 | 0.05 | 2.0 | 0.07 | 0.01 | 5.0 |
| **NESREA, 2011** | 0.05 | 1.0 | 0.06 | 0.01 | 4.0 | 0.05 | 1.0 | 0.06 | 0.01 | 4.0 |

**Chromium**

Chromium ion is one of the essential micronutrient needed by animals and plants. Chromium is considered as a relative biological and pollution significance clement Aggarwal et al, (2000). In the present investigation table 1.0, the concentration of chromium lies between 0.073- 0.078 mg/l in peak dry season and 0.039- 0.048 mg/l during peak rainy season as shown in table 1.0. In our study the chromium concentration is recorded well within the permissible limit set by WHO and NESREA 2011 as (0.05mg/l) standard during rainy season as indicated in figure 1.0. This results is in line with the results obtained by Sirajudeen*et al,* 2012.However, the concentration of chromium during peak dry season is high which may be as result of untreated mine waste disposal that have infiltrated dipper into groundwater to contaminate the water in the dry season when water demand is higher at this period in the area in the month of April. This findings is also similar with the results obtained by Rajni, *et al,* (2017) during the study of heavy metal pollution in ground water of

Malwa region Punjab, India. The high concentration of chromium in the peak dry season is great source of concern to public health of consumers in this study area.

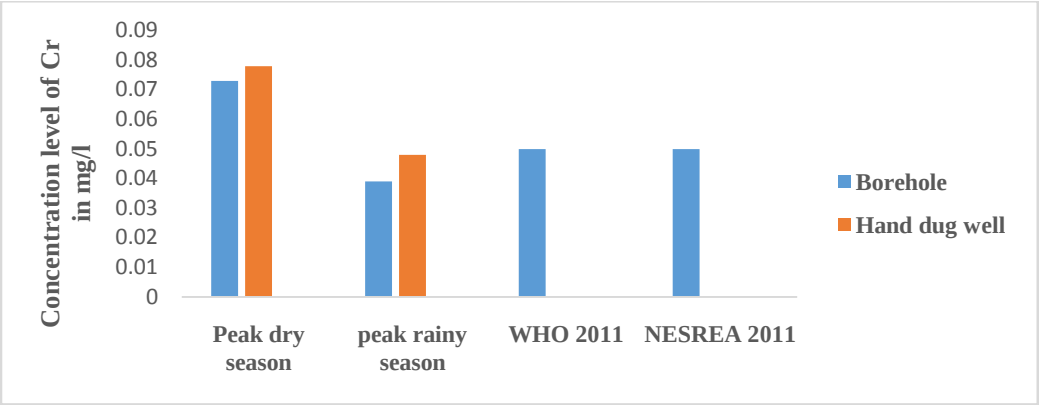


**Figure 1: Concentration of chromium in borehole and hand dug well water samples**

**Copper**

Copper is also among the essential element needed by human beings. It is distributed widely in nature on the earth. Copper can exist in aquatic environment in three forms namely soluble, colloidal and particulate Arul et al (2012). It is also found in less quantity as an essential element for organisms. In our study, the copper concentration ranged from 0.026- 0.0277 mg/l during peak dry season in boreholes and Hand dug wells water samples and from 0.017-0.199 mg/l in peak rainy season for bore holes and hand dug wells water samples as indicated in table 1, In our investigation, the copper concentration is recorded well within the permissible limit set by WHO 2011 (2.0 mg/l) and NESREA 2011(1.0mg/l) as shown in figure 2 below. Similar findings were also observed by James et al, 2015 who carried out an assessment ofheavy metals in ground water in kaltungo, Gombe state in Nigeria. The present finding revealed that copper ion in ground water does not seems to pose any hazard toconsumer's weather during the dry or rainy season of the year.

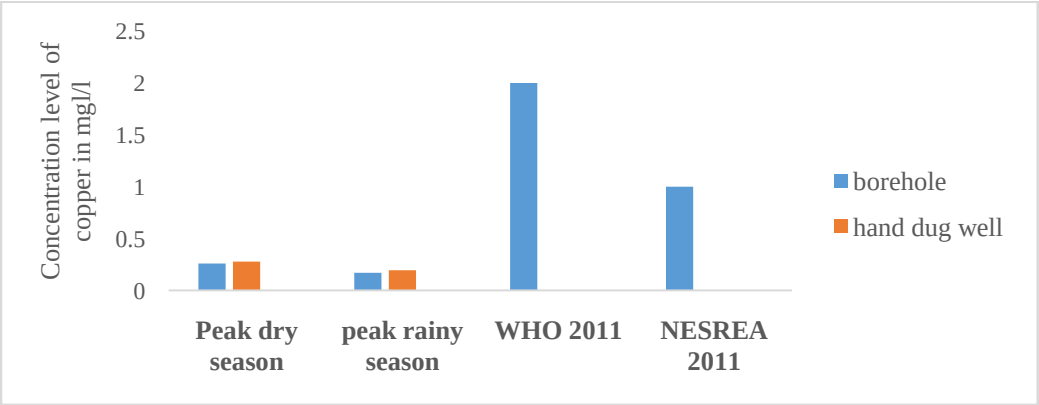


**Figure2: Concentration of copper in borehole and hand dug well water samples**

**Nickel**

Nickel element occurs in natural water as a divalent cat ion with pH range from 5–9. Nickel is a natural element on theearth's crust, therefore small amount are found in food, water and soil .In the present study the nickel ion concentration level is found to be 0.060 – 0.066 mg/l in dry season samples for the boreholes and hand dug wells respectively and it ranged between 0.041-0.045 mg/l in peak rainy season as demonstrated in table 1 above. Nickel ion concentration values in all the watersamples are below the permissible limit prescribed by WHO 2011 as (0.07mg/l) standard as presented in figure 3 below. The low level of Nickel (Ni) may be as a result of dilution effect of rain water during wet season. Similar trends of study were also observed by Sirajuddeen *et, al* 2012 in a study of seasonal variation of heavy metal contamination of ground water in and around of Uyyakondan district of Tamil Nadu, India. The present study indicates that nickel concentration level in ground water in Anka in within the safe level.

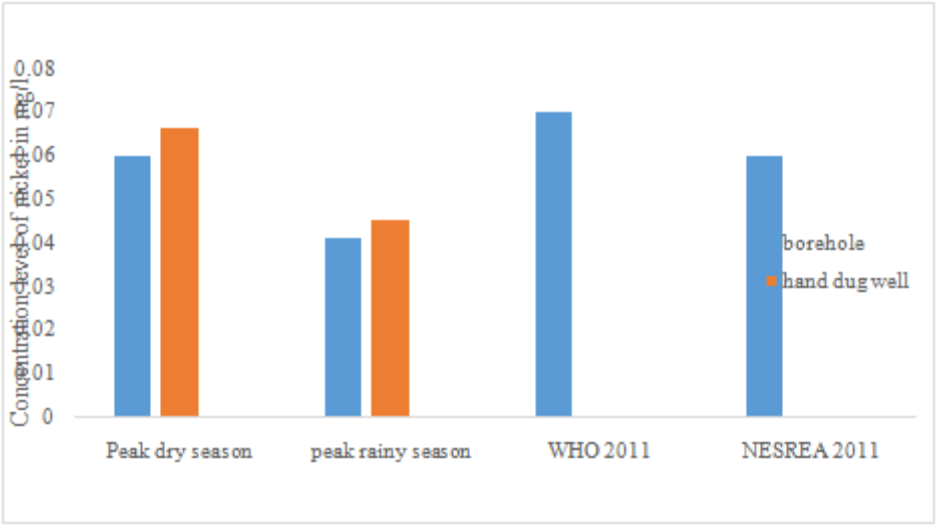


**Figure3: Concentration of Nickel in borehole and hand dug well water samples**

**Lead**

Lead occurs naturally in the environment. It is an undesirable trace metal, less abundantly found on the earth crust. It is also found in soil vegetation, animals and food. It is a serious cumulative body poison. Lead inhibits several key enzymes involved in the overall process of haemo-synthesis where metabolic intermediate accumulates. In the present investigation the lead ion concentration level ranges from 0.04-0.043 mg/l in dry season sampling and 0.022-0.023 mg/l in peak rainy season as showed in table 1. All the concentration levels of lead in both peak dry and rainy seasonwere observed to be higher than the permissible set by WHO and NESREA 2011 as (0.01mg/l) standards as presented in figure 4.0. The main sources of lead are industrial activities, gold mine activities household sewage, battery and alloy (Abduljameel *et al*, 2006). Lead is highly toxic and responsible for several cases of poisoning through food, and small quantities of lead may cause adverse changes in the arteries of human kidney and may causes high blood pressures and subsequent kidney damage. The presence of lead ion in groundwater as evidenced in our study from this study area is a serious course for concern to public health of consumers of this water source. Serious awareness is highly advocated to reduce the level of any possible effect.

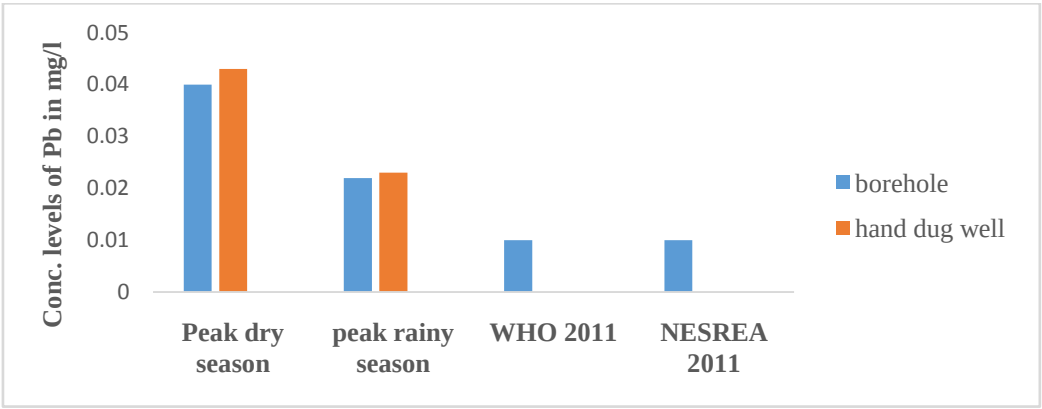


**Figure4: Concentration of lead in borehole and hand dug well water samples**

**Zinc**

Zinc ion is one among the important trace elements that play a vital role in the physiological and metabolic process of many organisms, and also has avital role inprotein synthesis. Nevertheless, at higher concentrations, zinc can be toxic to the living organisms (Naveen J. et al 2012).In the present study theconcentration of zinc ions ranged between 0.071-0.078 mg/l for boreholes and hand dug wells in peak dry season and 0.055-0.057 mg/l for boreholes and hand dug wells during peak rainy season on the study sides of the mining area as presented table 1 above. The values of zinc ions are however observed to be within the limit of WHO 2011 (5mg/l) and NESREA 2011 (4mg/l) standards as shown in figure 5 below. The ground water samples of borehole and hand dug wells in the present study area does not seems to cause a treats to consumers.

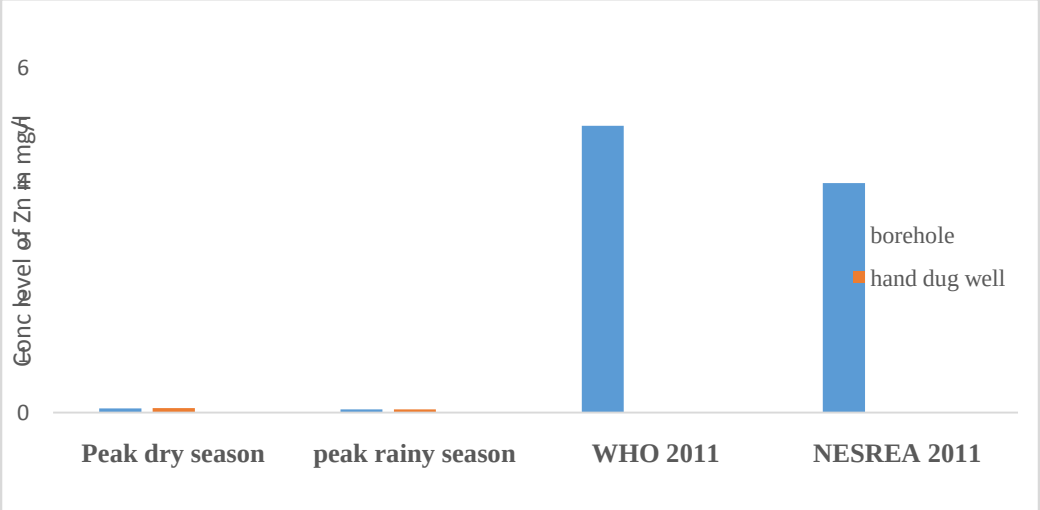


**Figure5: Concentration of Zinc in borehole and hand dug well water samples**

## V. Conclusion

Heavy metals Cr, Cu, Pb, Zn and Ni concentration levelswere determined in borehole and hand dug wells water samples during the peak periods of dry and rainy season in the year 2017.In the present study, we found that lead element Pb and Cr ion are present in a relatively higher concentrations as compared to the permissible limits set by WHO and NESREA 2011 standard in drinking water, whereas, Cu,Ni and Zn concentration levels is below the permissible limit prescribed byWHO and NESREA 2011 standards.The ground water samplesin the study area showed that all the water samples were within the safe limitexcept for lead Pb and Cr elements. It is quite evident that these heavy metals Pb and Cr may enter the food chain, and throughbioaccumulation and bio-magnifications. Regular monitoring of the water quality is thus required to assess theheavy metal concentration levels in water so that remedial measures can be adopted to save the ground water from subsequent heavy metalpollution/contamination.

## Acknowledgement

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