American Journal of Environmental Protection
2014; 3(6-2): 25-29
Published online December 24, 2014 (http://www.sciencepublishinggroup.com/j/ajep)
doi: 10.11648/j.ajep.s.2014030602.14
ISSN: 2328-5680 (Print); ISSN: 2328-5699 (Online)

Distribution of heavy metals in surface and ground water in Mkpuma Akpatakpa and Environs

Wazoh Hannatu[1], Ikechukwu S. B.[2], Gusikit Rhoda[1], Bala D. A.[3], Ajol Fubre[1]

[1]Department of Geology, University of Jos, Jos, Ngeria
[2]Nigerian Army Engineers (NAE), 23 Support Engineer Regiment, Maxwell Khobe Cantonment, Rukuba, Jos, Nigeria
[3]Department of Science Laboratory Technology, University of Jos, Jos, Nigeria

Email address:
hannatuwazoh@gmail.com (W. Hannatu), gusikitr@yahoo.com (G. Rhoda)

To cite this article:
Wazoh Hannatu, Ikechukwu S. B., Gusikit Rhoda, Bala D. A., Ajol Fubre. Distribution of Heavy Metals in Surface and Ground Water in Mkpuma Akpatakpa and Environs. *American Journal of Environmental Protection.* Special Issue: Integrating Earth Materials, Diet, Water and Human Health. Vol. 3, No. 6-2, 2014, pp. 25-29. doi: 10.11648/j.ajep.s.2014030602.14

Abstract: The inhabitants of Mkpuma Akpatakpa have resorted to the usage of water accumulated in the abandoned mine ponds and boreholes due to inadequate potable water within the area. Lead Zinc deposit which is typical of the Benue Trough has been mined within the area, leaving heaps of mine tailings at the site. A total of seven (7) water samples were collected and geochemically analyzed with the main objective of assessing their distribution in the waters of the study area. The results revealed the concentration of Arsenic to be high in both surface and groundwater ranging from 0.1 to 0.492mg/l. which exceeds the WHO limit for portable water. Constant exposure to Potentially Harmful Elements (PHEs) such as lead (Pb), cadmium (Cd), nickel (Ni), copper (Cu), cobalt (Co), zinc (Zn), and arsenic (As) have shown to have cumulative effects on human health since there is no homeostatic mechanism which can operate to regulate their toxicity. Heavy metals are released into the environment by natural and anthropogenic processes and these increase their concentration, hence leading to pollution. As the populace continues to be exposed to such hazardous element in their drinking water, the health implication could be prevalent overtime if not arrested.

Keywords: Arsenic, Risk, Heavy Metals, Abandoned Mine, Concentration

1. Introduction

Uncontrolled mining activities and illegal mining in developing countries has left a lot of environmental hazards and enormous amount of wastes and different types of pollutants are generated. Adverse environmental and ecological changes as a result of anthropogenic input has become more tangible and menacing (Tomov and Kanzimova, 2005).

Some heavy metals such as lead, zinc and cadmium in water are studied because they are related to environmental problems and also have accumulative properties. Traces of these metals are released into the environment, thus increasing their level and hence leading to pollution (Adediran et. al., 1990). The area of study falls within the lead-zinc mineralized area which has been mined and tailings of mine dumps accumulated on the site. According to Lar, 2009, water travels through rocks and soils as part of the hydrologic cycle and in the process leached elements in solution. When the leaked chemicals from the mining site slowly percolate through the layers of the earth, they reach the groundwater and pollute it. Mining can have adverse effects on surrounding surface and ground water if protective measures are not taken. The result can be unnaturally high concentrations of some chemicals, such as lead, cadmium, nickel, copper, cobalt, zinc, and arsenic. There is potential for massive contamination of the area surrounding mines due to the various chemicals used in the mining process as well as the potentially damaging compounds and metals removed from the ground with the ore.

The inhabitants within the study area have resorted in the usage of water from both the abandoned mine ponds and the groundwater and as a result could be exposed to high risk of these PHEs that might be leached into the groundwater or flow into the surface water from runoff. Hence, the need for this study. This research intends to determine the distribution of some heavy metals in waters of the area and highlight the possible hazards that the inhabitants could be exposed to.

2. Geology and Hydrogeology of the Study Area

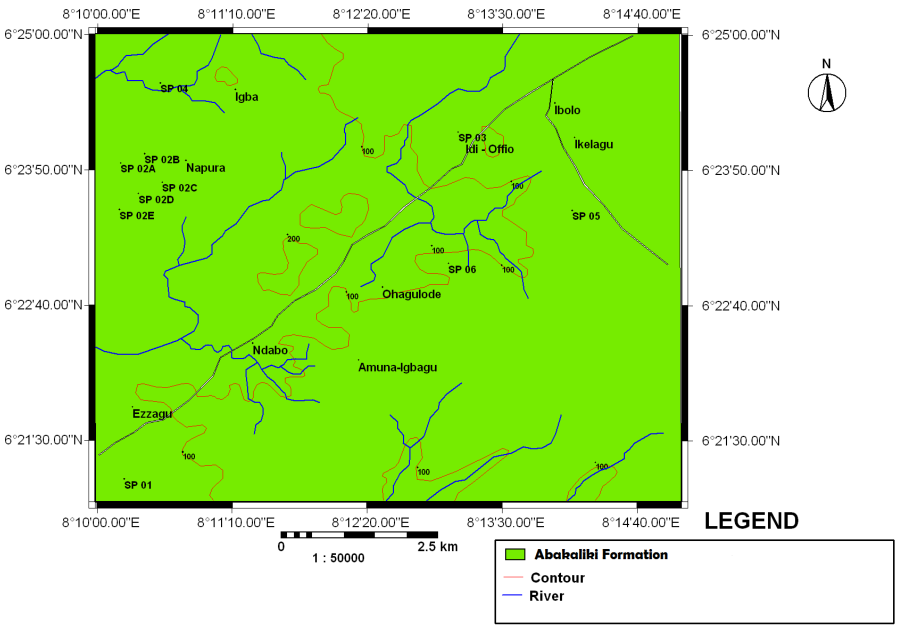

Figure 1. *Regional Geology of the study area (source: Nigeria Geological survey Agency, 2013)*

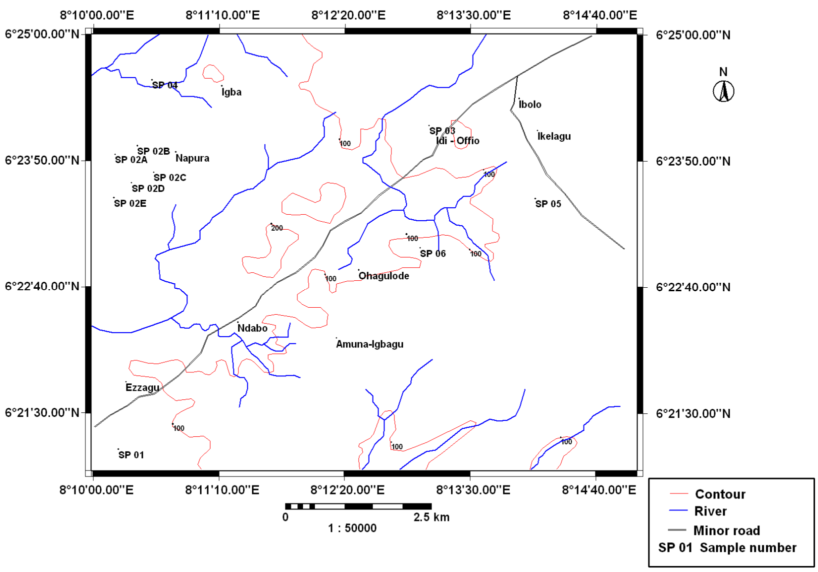

Figure 2. *A digitized map of the study area showing sample locations*

The study area is part of the Abakaliki shale Formation which lies within the Albian Asu River Group (Fig 2). The area is mainly characterized by rather poorly bedded shale, occasionally sandy, splintery metamorphosed mudstones, lenses of sandstones and sandy limestones are highly jointed and fractured. The major rock within the area is a fine grained clastic sedimentary rock composed of mud that is a mix of flakes of clay minerals and tiny fragments (silt sized particles) of other minerals, especially quartz and calcite. The shale around the area are mainly Red, brown and green colours which are indicative of ferric oxide (Hematite-reds), iron hydroxide (goethite-browns and limonite-yellow), or micaceous minerals (Chlorite, biotite and illite-green). Younger intrusive bodies in combination with numerous faults and joints system have the secondary porosity in the shale Formation. The fracture system which spreads across Abakaliki Anticlinorium and Afikpo syncline in the Benue rift during the deformational episode originated from vertical movement resulting from the rising and cooling of magma, which intruded the sediments in the Santonian time (Benkhelil, 1987). Palaeontologically, the study area is mainly characterized by species of *Mortoniceras* and *Elobiceras* (Reyment, 1965). Pelecypods and gastropods are also relatively rare. The sediments are folded and fractured and the fractures dip steeply particularly in the country south of Abakaliki; the fold axis stretch NW-SE. The lodes have connected vugs (Nwajide, 2013). The formation is associated with Lead-Zinc mineralization that stretches from Zurak to Abakiliki. Hydrogeologically, weathered rocks, alluvium and fractured zones form the aquifer in the study area. However, pockets of weathered and fractured rocks may form isolated groundwater reservoirs.

3. Methodology

Water samples from abandoned mine pits and underground water supplies were collected in bottles an around the study area for analysis (Fig.1).

The sample bottles were thoroughly washed, rinsed with detergent and dried for the sample collection, the sample bottles were treated with 0.1m nitric acid (HNO_3) solution (as acidification minimizes the adsorption of metals into the walls of the containers). Before collecting the water from any location, the bottle is washed three times with the water that is to be sampled. After the collection, two drops of nitric acid solution is added into the water sample. The water sample bottles were properly labeled according to the locations where they were collected from. The samples were taken to the cold room (freezer) instantly, after being tied in black cellophane. Analysis of the water samples was carried out using Inductive Coupled Plasma Optical Emission Spectrometry (ICP-OES) to determine their elemental concentrations.

4. Results and Discussion

4.1. Results

Results of the analyses for the seven (7) heavy metals in groundwater and abandoned mine ponds are as shown in Tables 1and 2 and figures 3, 4 and 5 below.

Table 1. *Concentrations of Heavy Metals (mg/l) in Mining Ponds*

parameter	coordinates	Zn	Pb	Cu	Cd	Ni	Co	As
Sp 02A	Lat N06^0 23^I 33.7^{II} Long 08^0 09^I 45.4^{II} Elevation 52m	0.056	0.011	0.000	0.002	0.001	0.001	0.110
Sp 02B	Lat N06^0 23^I 58.06^{II} Long E08^0 09^I 45.4^{II} Elevation 51m	0.021	0.011	0.000	0.002	0.001	0.001	0.111
Sp 02C	Lat N06^0 23^I 43.33^{II} Long E08^0 10^I 33.46^{II} Elevation 53.2m	0.000	0.012	0.000	0.003	0.001	0.001	0.139
Sp 02D	Lat N06^0 23^I 37.52^{II} Long E08^0 10^I 21.15^{II} Elevation 54m	0.000	0.007	0.000	0.002	0.001	0.001	0.119
Sp 02E	Lat N06^0 23^I 29.07^{II} Long E08^0 10^I 11.44^{II} Elevation 50m	0.064	0.006	0.000	0.003	0.002	0.001	0.139
WHO(2008)		5.00	0.05	2.00	0.01	0.07	0.01	0.01

Table 2. *Concentrations of Heavy Metals (mg/l) in Groundwater*

parameter	Coordinates	Zn	Pb	Cu	Cd	Ni	Co	As
Sp 01	Lat N06^0 19^I 42.6^{II} Long E08^0 04^I 13.2^{II} Elevation 67m	0.032	0.014	0.001	0.003	0.002	0.002	0.492
Sp 03	Lat N06^0 24^I 13.0^{II} Long E08^0 13^I 27.8^{II} Elevation 83m	0.104	0.020	0.001	0.005	0.003	0.002	0.010
Sp 04	Lat N06^0 24^I 24.9^{II} Long 08^0 10^I 59.3^{II} Elevation 71m	0.105	0.015	0.001	0.004	0.002	0.002	0.166
Sp 05	Lat N06^0 23^I 12.2^{II} Long E08^0 14^I 27.2^{II} Elevation 90m	0.102	0.029	0.001	0.006	0.004	0.003	0.293
Sp 06	Lat N 06^0 22^I 35.8^{II} Long E08^0 13^I 18.8^{II} Elevation 75m	0.115	0.010	0.000	0.002	0.001	0.001	0.450
WHO (2008)		5.00	0.05	2.00	0.01	0.07		0.01

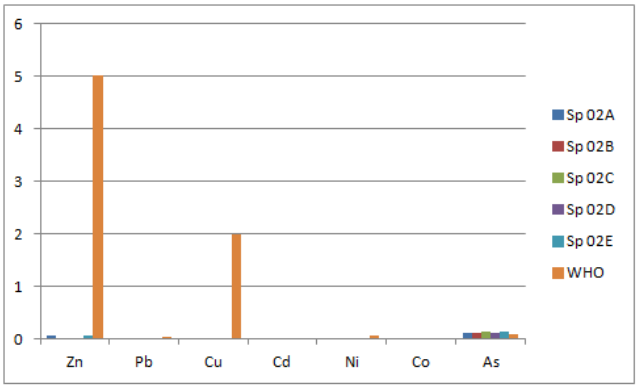

Figure 3. *Distribution of heavy metals in mine ponds*

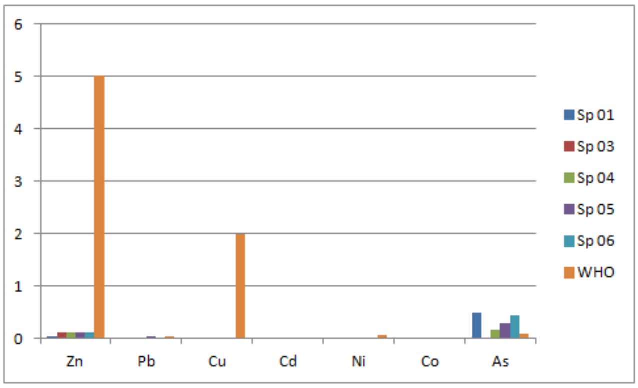

Figure 4. *Distribution of heavy metals in ground water*

Footnote:
SP-Sample Points
SP 01-Ezzagu Junction
SP 02A - 02E-Mkpuma Akpatakpa Abandoned mine
SP 03-Indi – Offie
SP 04-Health Centre, Iboko
SP 05-Ikelagu/Ndiogbo
SP 06-Ohagulode village

Table 3. *Primary and Secondary water quality standards and sources of contamination for selected elements in drinking water.*

Elements	Acceptable Concentration (Mg/l)	Sources of Contamination
Arsenic	0.01	Herbicides used on land and water
Cadmium	0.01	Mine tailings and industrial effluents
Copper	1.00	Aquatic herbicides
Lead	0.05	Industrial effluents and uses
Zinc	5.00	Natural occurrence industrial effluents
Nickel	0.01	Industrial effluents
Cobalt	0.01	Industrial effluents

Source: U.S. Environmental protection Agency (1989).

4.2. Discussion of Results

The study has revealed the various concentrations of these metals Zn, Cu, Cd, Pb, Ni, Co and As in both boreholes and abandoned mine ponds to be within the recommended limit by WHO standard except for arsenic which exceeds the acceptable limits.

The range of concentration of As in the study area is 0.110 – 0.492mg/l which exceeds the WHO admissible value of 0.01mg/l, this goes to suggest that both waters are contaminated. Groundwater which is considered to be the purest form of drinking water when compared to surface water (Offodile, 2002) in this case has higher concentration of Arsenic as compared to the water from the mine ponds which is expected to have higher values because of the mining activity that had taken place in the area.

This high concentration of As in the groundwater may be attributed to leaching from the ubiquitous fractures as presented by the geology and the lead Zinc mineralization of which Arsenic is usually associated with, hence when the leaked metal slowly percolate through the layers of the earth, it reaches the groundwater and pollute it.

In addition, Arsenic which is a naturally occurring element in the earth crust is adsorbed to or co-precipitated with iron oxide minerals; adsorbed to clay mineral surfaces; associated with sulphide minerals or organic carbon and these clay minerals are ubiquitous in the study area. The natural dissolving or desorbing of arsenic from these source materials may introduce arsenic into the groundwater. Conditions that favour the release of arsenic to groundwater include the presence of iron oxide and sulphide minerals in aquifer material. Hence there is a need for the environment to be guarded to prevent dispersion of these heavy metals since they are harmful to human.

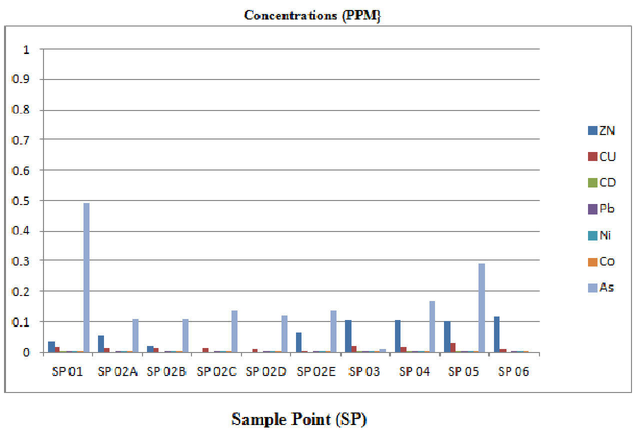

Figure 5. *A Bar chart showing the distribution of the various heavy metals within the study area.*

4.3. Health Impacts of Arsenic

Drinking well water with low to moderately elevated levels of arsenic over a long period of time may lead to chronic health effects. Chronic health effects such as cancer develop over a number of years and can be difficult to detect, especially in the early stages. Higher levels of arsenic can also lead to more immediate or acute health effects that usually have more noticeable symptoms. Water with low levels of arsenic may cause harm if it is consumed over a life time, sometime arsenic causes corns (hyperkeratosis) to develop on the palms of the hands, the soles of the feet and other places on the body. These corns may eventually become skin cancer. According to Jakupee et al., 2001, arsenic has surprisingly been noted to have anti-tumor properties in many situations.

Increasing evidence as indicated by Usman et al., 2013 is manifested in the Biu Volcanic Province of North-eastern Nigeria where the people displayed loss of hair and nails with lesions and roughness of the skin and skin growth due to the intake of arsenic in their drinking water. Studies have also linked long term exposure to arsenic in drinking water to increase risk of cancer of the bladder, lungs, liver and other organs. According to the United State Environmental Protection Agency (1989), the acceptable level at which arsenic could be tolerated is 0.01mg/l (Table 3). The level of arsenic in the borehole and abandoned mine pit where the populace source their water from is beyond the recommended limit. Those at Ezzagu (SP 01) and Ohagulode (SP 06) village could be at higher risks as the concentration of arsenic in the drinking water is high. As the populace continues to be exposed to such hazardous element in their drinking water, then the health impact discussed above could be prevalent overtime if not arrested.

5. Summary and Conclusion

The study has revealed the various concentration of these metals Zn, Cu, Cd, Pb ,Ni, Co and As in the water resources of the study area (entrapped water and borehole). The result shows that all other elements are within the recommended limit except for arsenic. The study suggests that the lead - zinc mineralization and the mining activity that took place in the area might be responsible for the contamination of the surface and groundwater through the fractured rocks of the trough. The arsenic is subsequently released from the soils into the groundwater thereby contaminating it. The continuous usage of the water by the people of this area over time predisposes them to various health complications if not monitored and abated.

In order to address this health risk, there is a need for a medical assessment to determine the Arsenic levels in the blood of the people living in the area with a view to prescribing and providing treatment facilities.

References

[1] Adediran G., Oleyede, O. and Oyindoye, J. A. 1990. Some heavy metal composition of some Nigeria soup condiments. Nig Food J., 9:13- 14

[2] Benkhelil, J. 1987. Cretaceous deformation, magmatism and metamorphism in the lower Benue Trough. Nigeria, Geol. Journ. 22, 467 – 493.

[3] Lar, U.A. 2009. Trace element and Health; some case studies from Nigeria: Nigerian Mapping Technical Assistance Programme, Kaduna.

[4] Offodile, M.E. 2002> Ground water study and development in Nigeria. Mecon Geology and Engineering services Ltd. 2nd edition, pp. 204 -2014.

[5] Jakupee, M.A., and Keppler, B.K., 2004. Gallium and other main group metal compounds as anti – tumour agents, Met. Ions Biol. Syst., 421, 425 – 462.

[6] Reyment, R.A 1965. Aspects of the Geology of Nigeria. Ibadan: University Press.

[7] Tomov, A., and Konzmova, K. 2005. Exploring possibilities of cultivation of unpolluted plant produce in lead and cadmium contaminated sites, J. Cen. Eur. Agric., 6: 121 – 126.

[8] Usman, A. M. and Lar, U. A. 2013. An overview of arsenic distribution in some parts of Biu Volcanic Province North – Eastern Nigeria. Earth Science, vol 2, No.6, pp.145-148.