



Scholars Research Library

Archives of Applied Science Research, 2012, 4 (4): 1567-1570
(<http://scholarsresearchlibrary.com/archive.html>)



Soluble and particulate metal contaminants in azare groundwater system

L.K. Akinola^{1*}, C.E. Gimba², L. Salihu³, P.A Egwaikhide⁴ and A.J. Nok⁵

¹Department of Chemistry, College of Education, Azare, Nigeria.

²Department of Chemistry, Ahmadu Bello University, Zaria, Nigeria.

³Department of Chemistry, Nigerian Defence Academy, Kaduna, Nigeria.

⁴Department of Chemistry and Centre for Biomaterial Research, University of Benin, Nigeria

⁵Department of Biochemistry, Ahmadu Bello University, Zaria, Nigeria

ABSTRACT

Investigation on the Partitioning of metal contaminants between the soluble and particulate phases in Azare groundwater system hereby reported. Water samples were randomly collected from twenty boreholes and twenty hand-dug wells within Azare town. Concentrations of K, Ca, Mg, Cu, Zn, Mn, Pb and Cd in these samples were determined as soluble and total metals using flame Atomic Absorption Spectrometry. The results of the investigation reveal that the proportions of the soluble metals in Azare groundwater are: 84.9% for K, 80.5% for Ca, 88.6% for Mg, 67.2% for Zn, 56.8% for Mn, 22.2% for Cu, 39.9% for Pb and 17.5% for Cd in the boreholes, and 93.1% for K, 87.6% for Ca, 91.8% for Mg, 69.3% for Zn, 76.3% for Mn, 22.5% for Cu, 44.5% for Pb and 42.5% for Cd in the wells. These findings suggest that, on the average, K, Ca, Mg, Zn and Mn were being transported predominantly as soluble metals while Cu, Pb and Zn were being transported predominantly as particulate metals in Azare groundwater system. The implication of the findings to availability and toxicity of metal contaminants in drinking water to living system depend largely on the forms in which the metals exist.

Key Words: Ground water, Metal Contaminants, Particulate Phase, Soluble Phase, Total Metals.

INTRODUCTION

Incidences of metal poisoning, such as Cadmium and Mercury poisoning in Japan and copper poisoning in Holland, have drawn the attention of Scientists and the general public towards the harmful effects of metals. In recent time, the magnitude of contamination of aquatic environment by metals in most Nigerian cities has increased tremendously. This, according to Ali *et al* (2005), is due to rapid urbanization and industrialization of most of these cities. The realization of this fact has led to the publication of many works, conducted on the levels of metal contaminants in both surface and ground waters in Nigeria (Yahaya and Sulaiman, 1999; Isihei and Okiemen, 2000; Edet *et al*, 2003; and Dike *et al*, 2004).

Unlike organic pollutants such as petroleum hydrocarbon and detergent which may visibly build up in an environment, metals may accumulate, to toxic levels unnoticed in the environments (Biney *et al*, 1999). Further more, organic chemicals generally break down with time in the environment but metals do not, and easily accumulate and concentrate in the living systems (Chemical and Engineering News, 2002).

Until recently, most environmental researches on metal contaminants in aquatic environment were based on the assessment of the total metal concentration, but it is becoming increasingly evident that the impact of a particular metal species may be more important than that of the total metal concentration. For instance, Forstner and Wittmann (1979) reported that when large quantities of silver ions are ingested, they remain impregnated in tissues, forming a

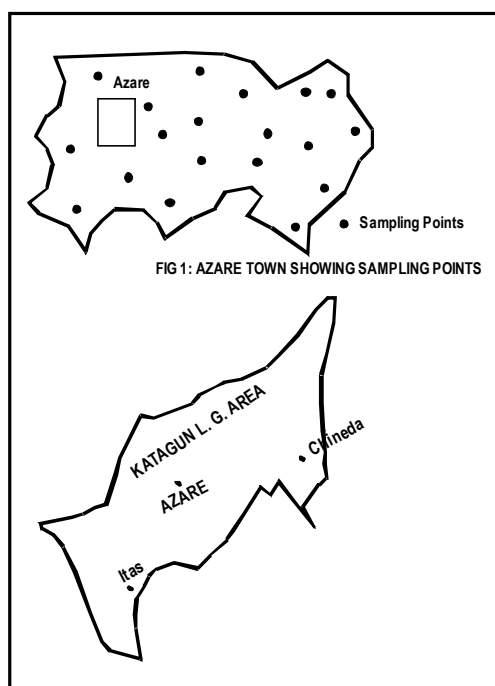
stable bond to —SH or —SR groups and this has been shown to be responsible for the permanent discolouration of skin and eye tissues. However, most insoluble salts do not pose any health risk to human if ingested because they are merely excreted in faeces.

In Azare, the headquarter of Katagum local government area in Bauchi State, Nigeria, majority of the people depend on groundwater from boreholes and hand-dug wells for drinking and other domestic uses. Although, it is an age-long belief among the people of Azare that groundwater, unlike surface water, is not vulnerable to contamination by metals, recent study on the levels of total metal concentrations in Azare groundwater system has shown that the groundwater system has been contaminated with metals, with Manganese, Lead and Cadmium exceeding the drinking water standards in most of the boreholes and hand-dug wells investigated (Akinola, 2006). Since the level of toxicity and availability of a metal to living system depend largely on the forms in which the metal exists rather than the total metal concentration, it is pertinent to determine the different forms in which metal contaminants exist in Azare groundwater system. In the present paper, a preliminary investigation on the partitioning of metal contaminants between the dissolved and particulate phases in Azare groundwater system was carried out with a view to assessing the proportions that exist as soluble and particulate metals in the groundwater system.

MATERIALS AND METHODS

Collection, Preservation and Preparation of Samples

In April 2006, water from twenty boreholes and twenty hand-dug wells within Azare town were randomly sampled for total and soluble metal contaminants analyse. In each of the sampling sites selected, two water samples were collected. The two samples contained about 1dm³ of water each, with one sample for total metal determination and the other for soluble metal determination.



Samples for total metal determination were immediately preserved as described by Van Loon (1980) while samples for soluble metal determination were filtered using 0.45µm filter membrane and the filtrate preserved. Then, 100cm³ portion was taken from each of the preserved samples and digested in accordance with the procedure described by the United State Environmental Protection Agency, USEPA (1983). All the reagents used for sample preservation and preparation were of analytical grade.

Analytical Technique

Total and soluble metal concentrations were determined in the samples by flame Atomic Absorption Spectrometry (AAS) using UNICAM 969 AA Spectrometer at the National Research Institute for Chemical Technology (NARICT), Zaria, Nigeria.

RESULTS AND DISCUSSION

Figures 1 and 2 show the average proportions of soluble and particulate metals present in water samples collected from boreholes and hand-dug wells respectively. Figure 1 indicates that K, Ca, Mg, Zn and Mn exist predominantly in the soluble phase while Cu, Pb and Cd exist predominantly in the particulate phase. The average proportions of these metals that were soluble in the boreholes are: 84.9% for K, 80.5% for Ca, 88.6% for Mg, 67.2% for Zn, 56.8% for Mn, 22.2% for Cu, 39.9% for Pb and 17.5% for Cd.

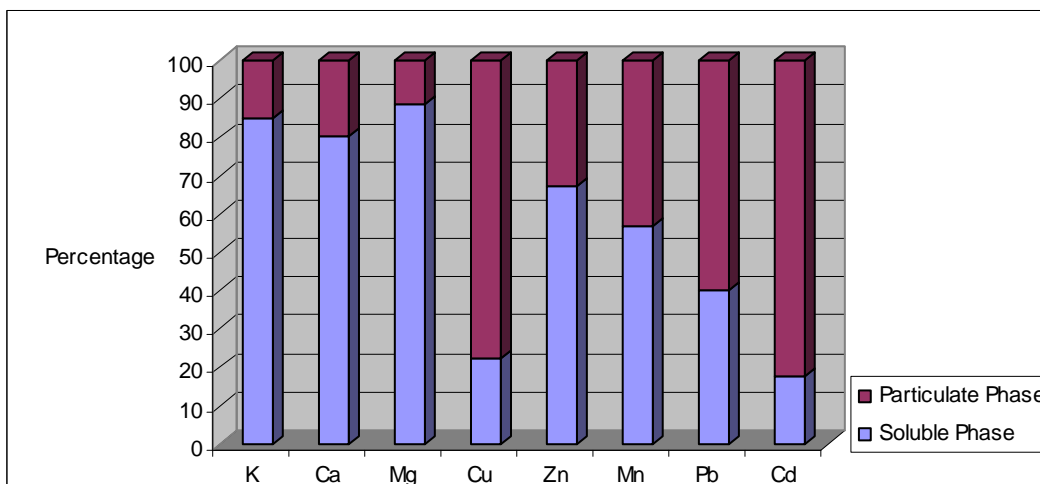


Figure 1: Proportions of Metal Contaminants in the Soluble and Particulate Phases in Boreholes

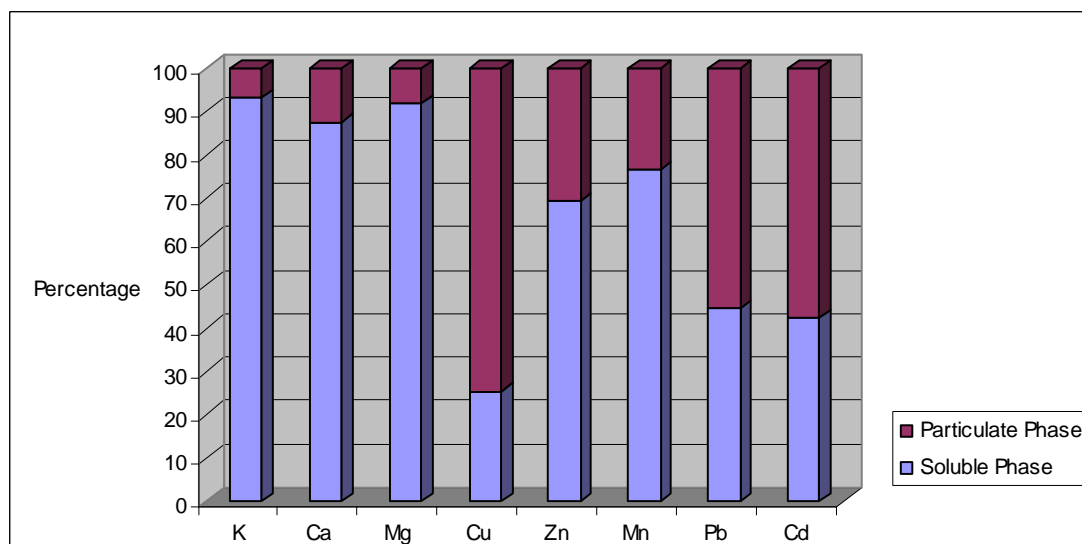


Figure 2: Proportions of Metal Contaminants in the Soluble and Particulate Phases in Hand-Dug Wells

Similarly, in the wells, K, Ca, Mg, Zn, and Mn exist predominantly in the soluble phase while Cu, Pb and Cd exist predominantly in the particulate phase (see figure 2). The average proportions of the soluble metal contaminants in

the wells are: 93.1% for K, 87.6% for Ca, 91.8% for Mg, 69.3% for Zn, 76.3% for Mn, 22.5% for Cu, 44.5% for Pb and 42.5% for Cd. These are relatively higher than those obtained in boreholes.

A study conducted by Yeh (1999) on Erh-Jen estuarine indicates that Fe, Zn and Cu exist predominantly in dissolved phase, while Mn and Ni exist predominantly in colloidal phase. Nquyen *et. al* (2005) also observed that about 70% of Zn, Co, Cd, and Pb exist in the particulate phase in Lake Balaton. It has also been shown that the particulate fractions of total metals in Vistula River represented about 6% for Ni, 33% for Mn, Zn and Cu, 80% for Fe and 89% for Pb (Sokolowski *et al*, 2001). The disagreement between these findings and the results of the present study may be explained in terms of variations in the factors that govern the physico-chemical behaviours of metals in aquatic environment. It has been demonstrated that factors such as flow rate, pH, organic matter contents and dissolved oxygen affect the concentrations of metals in the dissolved and particulate phases in natural water system (Pettine *et al*, 1994 and Sokolowski *et al*, 2001) and these factors vary with seasons and locations.

CONCLUSION

On the average, K, Ca, Mg, Zn and Mn exist more in the dissolved phase while Cu, Pb and Cd exist in larger proportions in the particulate phase in both the boreholes and hand-dug wells investigated. The implication of the findings to human health in Azare can be appreciated, if due consideration is given to the fact that availability and toxicity of metals in drinking water to living systems depend largely on the forms in which the metals exist in drinking water to living system was discussed.

REFERENCES

- [1] Ali, N; Oniye, S.J; Balarabe, M.L and Auta, J. (2005): *ChemClass Journal* 2, 69-73
- [2] Biney, C; Amuzu, A.T; Calamari, D; Kaba, N; Mbome, I.L; Naeve, H; Ochumba, P.B.O; Osibanjo, O; Radeconde, V and Saad, M.A.H (1999): Review of Heavy Metals. In FAO CORPORATE DOCUMENT REPOSITORY: Review of Pollution in the African Aquatic Environment. Retrieved November 16, 2006 from <http://www.fao.org/docrep/008/v3640e/V3640E04.htm>.
- [3] Chemical and Engineering News (2002): October 21, 2000 Edition. p40.
- [4] Dike, N.I; Ezealor, A.U and Oniye, S.J (2004): *ChemClass Journal*. Pp.78-81
- [5] Edet, A.E; Merkel, B.J and Offiong, O.E (2003): *Environmental Geology* 44(2),137-149
- [6] Forstner, U. and Wittmann, G.T.W (1979): *Metal Pollution in the Aquatic Environment*. Springer – Verlag. Berlin.
- [7] Isihei, T.O and Okieimen, F.E (2000): Assessment of the Quality of Drinking Water in Efurun, Delta State. Chemical Society of Nigeria's 23rd Annual Conference Book of Abstracts.
- [8] Nquyen, H.L; Leermakers, M; Elskens, M; De Ridder, F; Doan, T.H; and Baeyens, W (2005): *The Science of the Total Environment* 341(1-3): 211-226.
- [9] Pettine, M; Camusso, M; Martinotti, W; Marchetti, R; Passino, R and Queirazza, G (1994): *The Science of the Total Environment* 145(3): 243-265.
- [10] Sokolowski, A; Wolowicz, M and Hummel, H (2001): *Marine Pollution Bulletin* 45(10): 967-980.
- [11] United States Environmental Protection Agency, USEPA (1983): Methods for Chemical Analysis of Water and Wastes. Retrieved November 21, 2006 from <http://www.uga.edu/~sisbl/epaman4.html>
- [12] Van Loon, J.C. (1980): *Analytical Atomic Absorption Spectroscopy: Selected Method*. Academic Press. New York.