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Investigation on Trace Metals Content of Some Selected Borehole Waters Around Umuahia Metropolis

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Abstract: Water samples collected from producing boreholes in and around Umuahia metropolis were analyzed to establish the presence of trace metals, their concentrations and compare them with World Health Organization (WHO) guidelines on drinking water. Analytical results obtained using A.A.S Unicam Solar 32 showed that only Fe and Mn were detected and were within (WHO) highest desirable limit. The total content of Mn and Fe were found to range from BDL to 0.434 ppm and 0.0999 to 0.295 ppm, respectively. In the various samples investigated Zn, Ni, Cr, Cd, Pd and Hg were found below detectable limit. The pH of all the samples were near neutral.

Key words: Trace metals, borehole water, WHO, metropolis, investigation

INTRODUCTION

Umuahia metropolis is the capital city of Abia State, a town with fast growing commercial and industrial enterprises with a resultant increase in the population of urban settlement. There is therefore a commitant outstretching of existing basic amenities-electricity, housing and most importantly pipe borne water supply, which has virtually become a thing of the past in the city. Alternative supply of water for domestic and industrial purposes has been diversified to the area of bore-hole and well drilling, stream and rain water collection and storage. The most prevalent of these is the bore-hole which has become the major source of water in the town.

Borehole is an underground water supply and like surface waters is never pure and will contain a variety of inorganic and organic compounds, insoluble materials in suspension including trace metals. Wastes from residential areas, industries and agricultural practices through migration and infiltration leave their original dumps-soil to ground waters through the soil-suck away pits (Menchi, 1994). The trace elements content of soils depend o the nature of the parent rocks and the amount of sewage, sludge industrial wastes, fertilizer and impurities entering the soil which may contain heavy metals-trace such as Lead, Chrome, Nickel, Silver, Cadmium etc. The effect of uncontrolled disposal systems in Nigeria in general and Umuahia in particular can render ground water and surface waters unsafe for human, agricultural and recreational use, pose a threat to human life and is therefore against the principle of sustainable development (Benka and Bafor, 1999).

Pollution of these water bodies arises when the mineral deposits or elements are in concentration injurious or toxic to human and aquatic life Duxbury and Duxbury (1997). Heavy metals concentration in water bodies increase with increased suspended matter from sewage of growing population (Pickering and Owen, 1994). A knowledge of the concentrations and distribution of trace metals in ground water can play a vital role in detecting sources of ground water pollution especially in rapidly developing towns Umuahia. Edet and Ntekum (1996) observed that analysis of cations Ca^{2+}, Na^{+}, K^{+} and Mg^{2+} and anions SO_4^{2-}, Cl^{-}, HCO3 are regularly carried out in water development agencies but little or no attention is paid to trace metals analysis. Considering the numerous boreholes springing up in the developing town of Umuahia and the adverse effect of trace metals pollution or deficiency in water (Corine and Laweer, 1977); Goyer (1991), Strause and Saltmem (2000) WHO (1996a), Selinger (1986), Nwadozie (1998), Owen and Pickeing (1994), Odukoya *et al.* (2001), Goyer (1996). A study of the distribution and concentration of trace metals in the boreholes waters become very relevant. Previous research in Umuahia were centered on the physiochemical properties and no attention was given to trace metals Oji (2000), Daniel (2000). This research sets out to examine the trace metal content of the borehole waters in Umuahia and assess how far they conform with the WHO guidelines/recommendations for drinking water.

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MATERIALS AND METHODS

Sample collection and storage/preservation: Water samples were collected from different boreholes located around and within the metropolis. The samples were collected along a series of N-S, E-W and central profile with a spacing of not greater than 2 km in between the samples within the metropolis and not less than 5 km for samples at the out sketch or around the metropolis. The samples were collected both in the morning and in the evening designated as N_1, N_2 from North axis, S_1, S_2 from South axis, W_1, W_2 from West and E_1, E_2 from east axis. Samples collected in the morning were identified by (m) while (a) denote evening collections. (1) shows the samples from the outsketch (around) the metropolis while (2) denotes samples from within the metropolis. Samples were collected once a month for three months and average of analysis is taken.

The samples were collected form taps opened to the consumers. They were collected in a clean polyethylene plastic bottles and stored immediately in a cooler. From each site, two samples were collected, of which one was acidified with concentrated HNO_3 to preserve the ions in the solutions. All chemical used were of the analytical grade and obtained from BDH.

Experimental

pH Determination: The pH of each sample was measured using pH meter

Electrical conductivity determination: The conductivity was measured with electrical conductivity meter and expressed in US cm^{-1} (Micro Stroud cm^{-1}).

Salinity (Chloride ion test): Twenty cm^3 of each samples was measured into a conical flack and 1 cm^3 of 0.02M H_2SO_4 solution was added to it. The solution was then titrated with 0.02N $AgNO_3$ solution using 5% K_2CrO_4 indicator to a reddish brown equivalent point of silver chromate. The titre value was taken and chloride content calculated as follows:

$$Cl^- = \frac{1000 \times cm^3 \text{ of } 0.02M\ AgNO_3\ mg\,dm^{-3}}{\text{Volume of sample used}}$$

Trace metal analysis: The water samples were acidified with aliquot of HNO_3. About 100 mL each of the well-mixed acidified water was digested with 5 mL HCl. The digested samples were then analyzed for Fe, Ni, Cr, Cd Mn, Zn, Hg and Pb using atomic absorption spectrometer (Pye-Unicam Model Sp). For Chromium (Cr) before the absorption measurement, 100 mL of each samples were pippetted into a 50 mL conical flask where 1.0 mL of 8-hydroxyquinoline solution was added. This was to eliminate the interference of Fe, Ni and Co at 100 μg L^{-1} as well as magnesium at 30 mg L^{-1}.

RESULTS AND DISCUSSION

Analytical result of the trace metals content of the borehole waters are shown on Table 1 while some of the physiochemical properties are in Table 2. Except for the iron (Fe) and magnesium Mn all other trace metals were below detectable limits. This contradicts the expected result as was reported by Chester and Voutsinou (1981) for urban water. The deviation could be because most trace metals form compounds which sink into the mud,therefore are tightly fixed in the muck layer and are undetected Giesy and Hoke (1991).

Table 1: Trace metals concentration in borehole water around Umuahia metropolis in mg L^{-1} or ppm

Sample (ppm)	Fe	Mn	Zn	Ni	Cr	Cd	Pb	Hg
N_1 (m)	BDL	0.099	BDL	BDL	BDL	BDL	BDL	BDL
N_2 (m)	0.134	0.167	BDL	BDL	BDL	BDL	BDL	BDL
S_1 (m)	0.100	0.177	BDL	BDL	BDL	BDL	BDL	BDL
S_2 (m)	0.430	0.295	BDL	BDL	BDL	BDL	BDL	BDL
W_1 (m)	0.094	0.124	BDL	BDL	BDL	BDL	BDL	BDL
W_2 (m)	0.177	0.188	BDL	BDL	BDL	BDL	BDL	BDL
E_1 (m)	0.114	0.180	BDL	BDL	BDL	BDL	BDL	BDL
E_1 (m)	0.220	0.199	BDL	BDL	BDL	BDL	BDL	BDL
N_1 (a)	0.064	0.220	BDL	BDL	BDL	BDL	BDL	BDL
N_2 (a)	0.164	0.142	BDL	BDL	BDL	BDL	BDL	BDL
S_1 (a)	0.134	0.170	BDL	BDL	BDL	BDL	BDL	BDL
S_2 (a)	0.434	0.183	BDL	BDL	BDL	BDL	BDL	BDL
W_1 (a)	0.140	0.182	BDL	BDL	BDL	BDL	BDL	BDL
W_2 (a)	0.295	0.172	BDL	BDL	BDL	BDL	BDL	BDL
E_1 (a)	0.120	0.189	BDL	BDL	BDL	BDL	BDL	BDL
E_1 (a)	0.270	0.220	BDL	BDL	BDL	BDL	BDL	BDL
Min	BDL	0.099	BDL	BDL	BDL	BDL	BDL	BDL
Mean	0.117	0.180	BDL	BDL	BDL	BDL	BDL	BDL
Max	0.434	0.295	BDL	BDL	BDL	BDL	BDL	BDL
WHO/PA	0.300	0.100	5.00	0.050	0.100	0.005	0.000	0.002

Table 2: Some physiochemical parameters of the borehole in Umuahia metropolis

Sample	pH	Conductivity	Salinity	Temp °C
N_1 (m)	7.20	50.90	9.40	30.3
N_2 (m)	6.75	21.60	6.18	29.5
S_1 (m)	7.15	32.40	10.33	30.2
S_2 (m)	7.50	71.40	10.52	29.9
W_1 (m)	6.48	165.30	12.70	31.2
W_2 (m)	7.35	56.30	8.66	30.5
E_1 (m)	7.20	22.80	11.20	30.9
E_1 (m)	7.70	32.30	6.87	30.1
N_1 (a)	7.70	48.80	14.97	30.4
N_2 (a)	7.18	151.65	11.34	29.7
S_1 (a)	7.30	31.50	12.12	30.3
S_2 (a)	7.23	66.60	20.21	30.1
W_1 (a)	7.30	161.70	8.25	31.3
W_2 (a)	7.60	55.20	10.60	30.6
E_1 (a)	7.25	30.40	12.20	30.9
E_1 (a)	7.20	28.40	11.71	31.0
Min	6.48	15.65	6.18	29.5
Mean	7.25	64.20	11.70	30.4
Max	7.70	165.30	20.21	31.3
WHO/PA	6.5-8.5	14.000	200-600	30.0

Although previous research on heavy metals on Umuahia metropolis soils showed high trace metals pollution (Onyegbule, 2000) but most of them have low nobilities for instance Ni, Hb, Cd-low, Pb and Zn very low, and Hg-low (Pitt, 1994). Thus they reside in the soil. The soil location of the borehole could have contributed to the low level of trace metals and also the soil composition, which are not sandy (Cohen *et al.*, 1990).

The borehole around the metropolis contained less amount of trace metals (i.e., sample). This could be explained by the absence of industries, sewage and sludge disposition, refuse dumps the main source of pollution (Adriano, 1986; Benka-Coker and Bafor, 1999). These boreholes more portable than the ones within the metropolis. Most trace metals have tendency to precipitate at pH near neutral (Forstner and Wittman, 1983). Form the result the pH of all the samples were near neutral, thus the fall of the concentration of the metals below detectable limits.

Previous research on water quality of bore-hole waters in Umuahia showed acidic nature Oji (2000) but this recent research contrasts this fact but agrees with the findings of (Daniel, 2000). This may be due to the dependence of chemical composition (pH) of water on the hydro-metrological conditions and the season (Belan, 1979).

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