Possible Lead Contamination of AU Lake Water

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ABSTRACT:

Of the six most toxic metals lead, cadmium, nickel, antimony, mercury and beryllium; lead is the highest environmental contaminant.

Although organic contaminants are thought to be generally more hazardous than inorganic ones, lead hazard cannot be ignored because it can be enhanced by its ability to accumulate in bones and other tissues (bioaccumulation) leading to a cumulative amount, which may exceed the fatal level. Lead poisoning can lead to mental retardation, convulsions and coma.

Assumption University (AU) is sandwiched by two heavily used roads, hence the possibility of lead pollution is apparent. Thus, examination of AU campus for lead pollution is necessary. Since it is easier to measure lead in water environment, AU lake is chosen as a preliminary investigation site.

Atomic Absorption Spectroscopic (AAS) method of chemical analysis is chosen because of its sensitivity (ng/mL), availability (AIT, SERD environmental laboratory) and accessibility at the rate of B500 per sample .

The AU lake water is lead free. However, this does not absolutely imply absence of lead contamination. Further work for resolution of presence/absence of lead contamination is suggested.

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Keywords: ***Lead pollution; Water pollution; AAS lead measurement***

1.INTRODUCTION

AU lake has a soothing effect on both spirit and body. It enfolds us in its cool, calm bosom and relieves tensions. It is a boon to the University, and everyone involved in designing and implementing the lake should be applauded for their dedication and foresight. However, the lake being close to the drainage system and the motor road, pollution may be heavy. Since food shops line the road, the drainage system can mainly introduce organic pollutants. Lead pollution can be caused by cars using leaded gasolines.

Pollutants of normal interest are **organics**, such as acetone (1),methane (2),CFC's(3) PAN (1), acrylamide and **metals**(4).Pollutants which can accumulate in the body are potentially more dangerous than those that cannot accumulate in the body. The former can have a cumulative effect where toxicity builds up to a fatal dose over the years.

The **essential trace elements** (elements required by the body), vanadium, chromium, manganese, iron, cobalt, strontium, nickel, selenium, including the non-metals fluorine and iodine, do not accumulate in the body.

The **non-essential trace elements**, some of which can accumulate in the body, may be classified as

(a) those that occur in high natural levels

and

(b) those that occur in low natural levels.

The former class consists of silicon, aluminium,titanium,barium,zirconium, niobium, lithium, lanthanum and gallium. They have low toxic orders.

The latter consisting of germanium, beryllium, argon, molybdenum, mercury, antimony, bismuth, cadmium, silver, selenium, gold and tellurium are high potentials for **industrial pollution**. Some accumulate in the body.

With respect to metals: the following six metals are considered to be **most toxic** (5) lead, cadmium, nickel, antimony, mercury, and beryllium. Nine metals, present in low concentrations (3 ppm in the earth's crust and less than 18 mg in man), are considered slightly toxic. They are tin, tungsten, germanium, pallidium, rhodium, tellurium, barium, chromium and cadmium.

The pollution sources, USEPA suggested chemical analysis and physiological effects in humans, of the six most toxic metals followed by some other contaminants of current interest are summarized below (lead is considered last).

Cadmium(Cd) is an insiduous toxin. Burning of fossil fuel introduces cadmium into the atmosphere. Pollution in other environments are caused by

electroplating and manufacture of batteries, pigments and alloys. It can replace zinc in the biological system, and can therefore interfere with zinc function in enzymes. Nausea, vomiting, diarrhea, muscular cramps, salivation, sensory disturbances, liver injury, convulsions, shock, renal failure and cardiopulmonary depression can occur.Atomic absorption spectroscopy(AAS) may be used for its chemical analysis.

Mercury(Hg) is introduced in the air by burning of fossil fuel. Other pollution can be caused by electrical appliances, dental amalgams, catalysts, pulp and paper manufacture and electrolytic production of chlorine and caustic soda. Inorganic and aryl mercury are not hazardous; but alkyl mercury, especially methyl mercury CH3Hg , is very toxic. Bioaccumulation in fish, meat, egg and poultry meat occurs as mercury can coordinate to sulphur atoms in protein molecules. Emesis, severe abdominal pain and loss of consciousness can occur. USEPA recommends flameless cold vapour technique for mercury chemical analysis.

Antimony(Sb) is a potential heart disease hazard. Air-borne **Beryllium (Be)** causes beryllosis, a chronic lung disease and **Nickel(Ni)** as nickel carbonyl Ni(CO)4 is carcinogenic (cancer causing agent), and can also cause dermatitis and respiratory track problems. Electroplating and stainless steel manufacture are sources of nickel pollution. USEPA recommends atomic absorption spectroscopy (AAS) for chemical analysis of nickel.

Before consideration of lead pollutant, it is in order to consider some of the other environmental contaminants which are of current interest in addition to the above.

Acrylamide, an aqueous pollutant, is released from its use as a paper and paper board strengthener. A concentration of 400 ppm causes widespread dysfunction of the central nervous system(CNS). HPLC and uv detectors are used for its chemical analysis.

Barium(Ba) used in drilling mud, pigment and x-ray contrast medium, can cause hypokalemia and electrocardiographic changes if present in concentrations of 2 micro gram per litre and above. The fatal dosage is 0.8 - 0.9 gram. USEPA suggests AAS for its chemical analysis.

Chromium(Cr) used as native metal or as chrome alloys in corrision control, mordant, anticorrosives, leather tanning, catalysts, paint pigments, fungicides, wood preservatives and cooling waters, can cause liver and kidney damage, internal haemorrhage, dermatitis and respiratory problems. Cr VI is more toxic than Cr III. AAS may be used for its chemical analysis.

Nitrates and Nitrites, present in inorganic fertilizers, explosives, glass, cured meat, heat-transfer and heat storage solar heaters, can cause asphyxia by combining with blood haemoglobin. USEPA suggests spectrophotometric cadmium reduction method for chemical analysis.

Of the major six toxic metals; lead, cadmium, nickel, antimony, mercury and beryllium; **lead is the largest environmental contaminant** (5). Lead accumulates in the bones and other tissues; it interferes with erythrocyte delta amino levulinic acid dehydrase, a red blood cell enzyme. Lead poisoning can cause mental retardation, convulsions and coma. This pollutant is especially dangerous because of its capability to accumulate in the body. There are a number of chemical analysis methods available.

Natural airborne lead contents are in the range 0.0005-0.0006ug /m3. This is caused by mobilization of silicate dusts from soils which has normal lead contents of 16 ppm (6). The main sink of this airborne lead is agglomeration and precipitation, sometimes alone and sometimes with rain.

Human activities has contributed towards magnification of airborne lead. For example, annual analysis of Greenland ice layers show an increase from 0.0005 ug/kg in 800 B.C to 0.21 ug/kg in 1965 (7). Antartic snow records of southern hemisphere shows lead pollution increased from 2.5 ng/kg, 1920-1950 period to 6 ng/kg , 1950-1980 period (9).

The majority of manmade lead emissions are from automobile exhausts. Some estimates state emissions of 1kg / day / capital. They account for 10% of urban particulates. Generally atmospheric lead contents are higher in the cities than in the surrounding areas; higher during the day than at night; and decreases steadily with distance from a street or expressway(9).

Gasolines used by four-stroke Otto-cycle engines of most cars, are rated by the **octane number**. 2,2,4-Trimethyl-pentane, a branched C8 hydrocarbon, is taken as a standard and arbitrarily assigned an octane number of 100. The octane number is a measure of the tendency to cause engine knocking. The higher the number the lesser the tendency.

Tetraethyllead (TEL) is used as an antiknock to raise the octane number of gasolines. Constant discharge of highly toxic lead into the atmosphere creates environmental problems.

To prevent this, **"unleaded" gasolines**, using 2,2,3 - trimethylbutane are and t-butylether antiknocks introduced. Even so, usage of leaded gasolines has not stopped entirely.

Since AU campus is sandwiched by two roads, which are frequently packed with cars, there is a strong possibility of concentrated airborne lead in the AU atmosphere, near the roads. Consequently, there is a definite possibility of lead contamination of AU lake (10).

A study of possible lead contamination is therefore necessary. A logical extension of this study will be determination of lead profiles in and around the AU lake. A study for treatment of lead polluted waters, using **aquatic plants** (11) (12), **membrane technology** (13), **electro-chemical precipitation** (14) or a combined

ecological/microbial **solar aquatic treatment** (15) will also be profitable .

1.1 Scope of this work:

Preliminary examination of lead in AU lake waters, to determine presence of lead pollution .

2.EXPERIMENTAL:

Since lead was expected to be present in small quantities, lead-free chemicals, collection vessels and sensitive instruments had to be used.

2.1 Chemicals:

Nitric acid (AR grade); deionized water.

2.2 Equipment:

Stoppered glass collection bottles; Atomic absorption spectrometer (AAS).

2.3 Procedure:

2.3.1 Choice of Analytical Method:

Conventional analytical methods (16) for lead determination consisted of the following:

(a)**Amperometric analysis** by potassium dichromate.

(b)**Electrogravimetric analysis**, determined as lead (IV) oxide.

(c)**Gravimetric analysis**, determined as chromate, iodate, sulphate, molybdate or piperidine dithiocarbamate.

(d) **High frequency analysis** by EDTA.

(e)**Volumetric analysis** by sodium thiosulphate or EDTA, also as chromate or iodate.

(f) **Solvent extraction** by dithizone .

(g)**Colourimetric analysis** by dithizone or as sulphide. The former method required a buffer made up of 2.5g sodium citrate and 4g sodium carbonate in 100 mL to control pH at 7. Lead dithizonate was extracted in carbon tetrachloride (CCl4) solvent and the absorbance was measured at 515 nm. The sensitivity was in the microgram range.

The latter method relied on the formation of brown colloidal lead (II) sulphide PbS. The absorbance was measured at 430nm. The sensitivity limit was about 0.005 milligram.

This sensitivity could not match that of **Atomic Absorption Spectroscopy (AAS).** AAS with a graphite furnace attachment has sensitivity limits about nanogram per millilitre (0.001 ppm) range(5).

An example of such an arrangement was the Perkin-Elmer model 300 SG attached to a HGA-74 furnace and 2100 furnace controller. Furnace processing condition examples were dry,110 C, 40 s; ash, 400 C, 20 s and atomize lead 2300 C.

If measured both at the major absorbance line of 217.0 nm and the lower sensitivity line of 283.3 nm, a

wide range of concentrations were covered at absorbances maintained between 0.05 and 0.5.

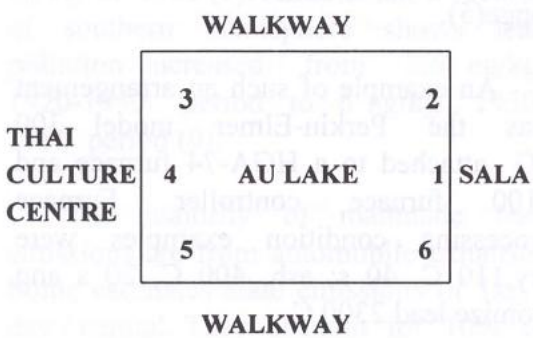
The sensitivity was improved further if electrothermal heating was used. Owing to local availability/ accessibility, AAS with furnace attachment was chosen as the experimental analytical method for determination of lead in AU lake.

2.3.2 Sampling

A dense sample collection was advocated for high confidence of the results. However, this was deemed necessary only if the preliminary results demanded it. Hence a low density sample collection was performed.

Water samples were collected from six designated sites of AU lake, at a depth of 20 cm, 1 m away from shore, Figure 1, and were stored in clean lead free stoppered glass bottles.

Figure 1. Water sample collection sites at AU lake



The bottles were previously treated with acidified dichromate, washed several times with distilled water and finally rinsed several times with deionized water. The last wash was checked for lead .

The collected water samples were pretreated for lead measurement ; by first adding 2 mL concentrated nitric acid to 1 mL of water sample, followed by 6 mL 25% nitric acid and boiling vigourously until almost dry. The sample was cooled to room temperature and the volume was made up to 100 mL, using untreated raw water sample. This was done so as to follow, as closely as possible, the procedure for pretreatment of ashed sample(12). Just before measurement, the treated water samples were heated and evaporated to half the original volumes ie. doubled concentration.

These samples were then measured for lead on an atomic absorption spectrometer, at the environmental chemical laboratory, School of Environmental Resources Division (SERD) of The Asian Institute of Technology (AIT). The results were shown below.

Table 1. Lead Contents of AU Lake Water Samples						
Site		Sample		Lead/ppm		
Site 1		Sample 1		ND		
Site 2		Sample 2		ND		
Site 3		Sample 3		ND		
Site 4		Sample 4		ND		
Site 5		Sample 5		ND		
Site 6		Sample 6		ND		

3.RESULTS AND DISCUSSION

The results of lead measurement by AAS were shown in **Table 1**. It was found that all the tested water samples had lead levels well below the detection limit of the instrument (0.1 mg/L). Therefore, lead was not detected even in doubly concentrated water samples. Thus it was concluded that AU lake water is free from lead .

The above lead free result for AU lake waters was a good outcome as it indicated the waters were safe with respect to lead contamination. However, lead pollution of AU lake could not be ruled out by these null results alone. The null results could be accounted for, by either of the following three factors:

(1)**Minimal Emission**.

Lead emission from automobiles was minimal.

(2)**Lead Screens**.

Roadside trees and fence vegetation could act as effective lead screens.

Lead emission by automobile exhausts would rise with the hot exhaust gases. Since lead is heavy, it would not be carried to a great height. Therefore, the high trees and fence vegetation could have acted as effective screens which kept lead out of the AU lake.

(3)**Natural water cleansing**.

Even if the lake were contaminated , lead being heavy sedimentation was possible. Lead would settle down and concentrate in the lower depths and in the sediment, and leave the water relatively lead free.

Determination of longitudinal (height/depth) lead profile in AU lake water and roadside atmosphere, as well as determination of lateral(width) lead profile around the lake area and on the roadside area were required to reveal causes for the lead free result.

If the lateral lead profile on the roadside area was high and the lateral lead profile around the lake was low, then it could be concluded that roadside trees and fence vegetation were effective lead screens. Then fence vegetation and tree screens could be suggested as a means for reducing lead pollution. This could possibly be applied to other automobile related pollutions also.

If the longitudinal lead profile in the roadside atmosphere, showed absence of lead , then it could be concluded that lead emission by cars was minimal.

If the longitudinal lead profile of AU lake waters shows absence of lead, then it could be said definitely that the AU lake is free from lead contamination, especially if the sediment is lead free. At present it can only be claimed that the AU lake ***water*** is lead free.

4.CONCLUSION

AU lake water was found to be free from lead. Further investigation is necessary for absolute exclusion of lead contamination.

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