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Zinc: Concentration Determination in Soil and Water and Its Transport and Distribution with Distance

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Greenokite mineral (cds) is present in ferruginous quartzite rocks which are present in Jhalana Dungari area, Jaipur. Zinc is supposed to be associated with cadmium. Zinc occurs together with cadmium generally in the ratio 100 : 1–1000 : 1. This paper presents the results of analysis of soil, rock and water samples for determining the concentration of zinc, its transport and distribution with distance from the quarrying area. The findings reveal that zinc concentration is not high in water samples and much below the permissible limit of 5 mg/L. The concentration in soil shows much variation, *i.e.*, from 2.4 to 42 mg/L. It is surprising considering the fact that the rock samples have maximum concentration of 8.8 mg/L. It appears that the concentration of zinc is high in stones which are removed by quarrying and used in grinders after crushing. The stone powder spreads in the nearby area and could increase zinc concentration.

Key words: Zinc, concentration, determination, soil, water

INTRODUCTION

Zinc is an essential trace element for plants and animals including human beings and it plays a vital role in metabolic processes. Zinc is found in traces, less than 1 mg/L, *i.e.*, well within the safe limits. Concentration above 5 mg/L causes disagreeable taste. In drinking water the level of zinc usually ranges from 0.995 to 1 ppm or mg/L, but in certain regions of the world it may rise up to 7.0 mg/L. Only a much higher than this range is toxic to organisms[1].

Zinc enters the domestic water supply from the deterioration of galvanized iron and dezincification of brass, besides industrial waste[2]. Zinc sulphide is the common ore and the metal is extracted through smelting. Zinc load of water in rivers passing near zinc smelters has been reported up to 25 mg/L. Zinc smelters are located at Alwaye (Kerala), Debari (Rajasthan) and Visakhapatnam (Andhra Pradesh)[3].

In the context of contaminated land redevelopment, excessive levels of this metal are considered problematic, primarily in connection with toxic effect on plant growth (phototoxicity). Effects are most marked when low pH and a lack of soil binding sites combine to enhance the availability of the metals to sensitive plant systems[4]. Zinc deficiency may also be prevalent in developing as well as developed countries where people consume diets with high cereal content (rich

in phytate) and refined food materials which decrease the overall intake of trace elements. Acute ingestion of alcohol appears to increase urinary zinc excretion[5].

Ferruginous quartzite rocks are present in Jhalana Dungari area, Jaipur. Greenokite mineral (cds) can always be suspected in such rocks. Cadmium is not found in pure state in nature. It is found as sulphide ring along with zinc ores. Cadmium occurs[6] together with zinc generally in the ratio 1 : 100–1 : 1000.

The aim of this work is analysis of crushed rock samples from different parts of the rock to pinpoint the source of pollution and then the analysis of water and soil samples from different areas to judge the transport and distribution of zinc.

EXPERIMENTAL

Standard procedure was adopted for the determination of concentration of zinc in water and soil at different distances and heights using Pye-Unicam SP9 series atomic absorption spectrophotometer[7].

RESULTS AND DISCUSSION

The mean, median and mode values calculated for water, soil and rock samples are presented in Table-1 and Fig. 1. The terms mean, median and mode are explained below:

Mean = average concentration
Median = concentration found in most samples
Mode = maximum concentration in any sample

TABLE-1
CONCENTRATION OF ZINC IN WATER, SOIL AND ROCK SAMPLES†

	Total No. of samples analysed	Median	Mode	Range	No. of determinations	Mean
Water	20	0.24	1.80	0.06–1.80	15	0.297
Soil:						
Zone-1	45	10.40	20.40	6.80–20.40	45	11.631
Zone-2	45	4.00	17.60	3.40–17.60	45	7.648
Zone-3	45	6.80	20.60	4.40–20.60	45	7.644
Zone-4	45	28.80	42.00	4.60–42.00	45	22.671
Zone-5	75	7.40	19.20	2.40–19.20	75	8.109
Zone-6	45	10.80	28.00	2.60–28.00	45	11.066
Rocks	24	6.40	8.80	4.40– 8.80	24	5.983

†All values are in mg/L.

Water analysis: A perusal of zinc concentration in water samples from different from different sources (Table-1) shows that it varies from 0.06 to 1.8 mg/L. A few samples from all the three sources did not have detectable amount of zinc. Even the maximum concentration 1.8 mg/L in surface water is found in one sample. In general, surface water has higher concentrations while open tank water has

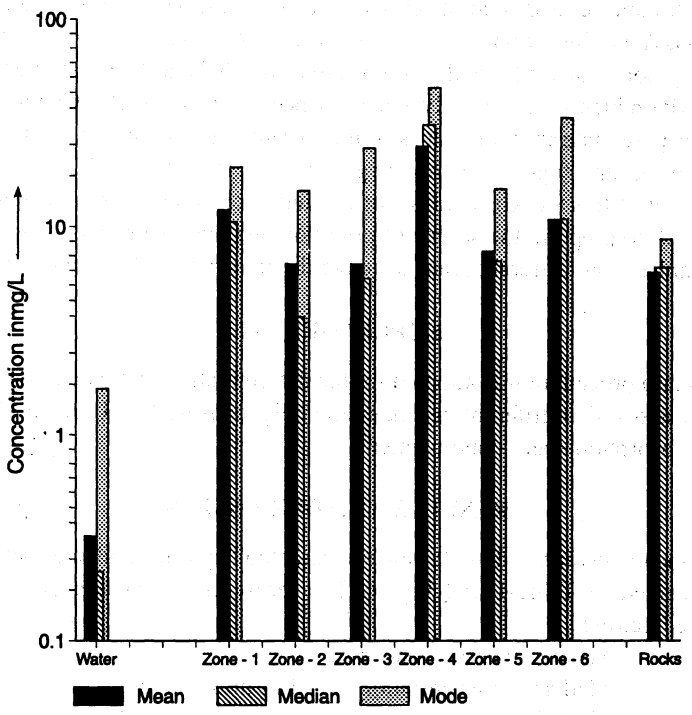

Fig. 1. Concentration of zinc in water, soil and rock samples

minimum concentration of zinc. It is reasonable to believe that surface water has contact with more of soil and dissolves more zinc compounds than open tank water which gets only dust from the hills. Underground water (T.W.) also has low concentration (0.08 to 0.24 mg/L) except one sample which has 1.04 mg/L of zinc. All these results indicate that insoluble zinc compounds are present in hard stones in larger quantity than in soft soil in the area of the present study. Surface water remains in contact with more soil for a longer time and dissolves more zinc but open tank water is in contact with comparatively much less amount of soil and hence has less quantity of zinc.The results of the present study of zinc in tubewell water also indicate the presence of hard rock containing zinc deep underground. Underground water, though in touch with large surface area of zinc containing soil, is not able to extract enough zinc and its concentration is low in tubewell water. Zinc concentration is well below the safe upper limit prescribed by WHO which is 5.0 mg/L.

Soil and rock analysis: The results of the present study on zinc concentration in the different zones and series are reported in Table-1. The variation in concentration of zinc is from 2.4 to 42 mg/L. Even the mode values of zinc in different zones are much higher than the mode values of zinc in the rock samples. Zone-6 has unexpectedly higher concentration of this metal than in Zones 1, 2, 3 and 5.

Investigations of the entire area of study revealed the existence of stone

crushers close to Zones 3 and 6. The crusher in Zone-6, though not very close, stopped working long back after active use for several years. Likewise, a crusher is also installed near Zone-3 which is in active use. It is, therefore, reasonable to believe that dust from these stone crushers containing high zinc content settled in these zones and the concentration variation of Zn is dependent on wind direction.

Distribution: Distribution pattern of Zn in Zones 4, 5 and 6 with height are presented in Table-2 and Fig. 2.

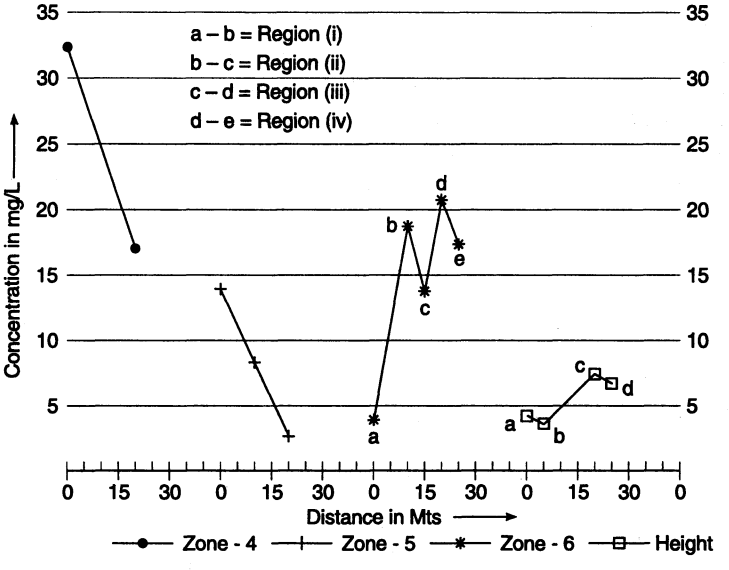

Fig. 2. Distribution of zinc in soil and rock samples

TABLE-2
DISTRIBUTION OF ZINC IN SOIL AND ROCK SAMPLES†

Distance in metres	Zone-4	Zone-5	Zone-6	Height
At the root of the hill	32.2	14.0	4.0	4.4
5	29.4	12.4	5.8	4.0
10	22.6	8.2	19.0	5.4
15	21.0	3.4	14.2	5.2
20	17.0	3.0	20.6	7.0
25	—	—	17.2	6.4

†All values are in mg/L.

A study of the variation of zinc concentration with equal distance shows that as we move from hill to populated area, the concentration of zinc decreases and follows a linear equation. Concentration of zinc in Zones 4 and 5 is decreasing with distance and follows a linear equation.

Variation of concentration of zinc in Zone-6 follows the following pattern:

In Region I	Concentration of Zn is increasing with distance
In Region II	Concentration of Zn is decreasing with distance
In Region III	Concentration of Zn is again increasing with distance
In Region IV	Concentration of Zn is again decreasing with distance

Variation of concentration of zinc with height follows the following pattern:

In Region I	Concentration of Zn is decreasing with distance
In Region II	Concentration of Zn is increasing with distance
In Region III	Concentration of Zn is again decreasing with distance

Thus except for Zone-5, where the concentration of zinc in soil decreases with distance, the zinc concentration is high in other zones, even 20 metres.

It is therefore easy to explain low concentration of zinc in water and variation in zinc concentration in soil as the metal is in high concentration in the hard stones and the wind direction controls the dust from the stone crushers. Area of Zone-5 is so situated that it is away from the crushers and only a little dust settled near the hill when the crusher in Zone 6 worked a few years back.

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