Trace elements in groundwaters of Hubli city, Karnataka, India

S. N. Hegde and S. C. Puranik

Department of Studies in Geology, Karnatak University, Dharwad 580 003, India

Twenty-two groundwater samples from Hubli city, Dharwad district, Karnataka, have been analysed for Fe, Mn, Cu, Zn, Ni, Pb and Cd. High concentration of toxic elements, viz. Pb and Cd, is noticed in a few samples. The probable sources for these elements are industries and also highway contamination. Immediate quality monitoring of groundwater is suggested in this area.

WITH the continuing growth and concentration of population and industries in Hubli city, Dharwad district, Karnataka (15°18′–15°23′ N, 75°6′–75°10′ E), the groundwater is being exploited indiscriminately and is used for various purposes, irrespective of its qualitative suitability. The city forms the southeastern part of Hubli-Dharwad Municipal Corporation area, which is built up on a Precambrian metasedimentary terrain, mainly consisting of shales. A study[1,2] on the quality of groundwater indicates a high concentration of chloride, total dissolved solids, calcium and sodium in the waters of both open and bore wells located in the vicinity of municipal sewerage systems, especially in the old areas of the city. In the present study, we have assessed the concentration of a few trace elements in the groundwater of this area.

Water samples from 13 open wells and 9 bore wells have been collected and analysed for Fe, Mn, Cu, Zn, Ni, Pb and Cd using atomic absorption spectrophotometer, following standard analytical methods[3].

The concentrations of various trace elements are presented in Table 1. Quality comparison with drinking water standards[4,5] is shown in Table 2. From Table 2 it is clear that Fe, Mn, Cu and Zn are within the range of permissible limits. However, in 13 samples Pb exceeds the permissible limit (0.1 mg/l) and in 9 samples Cd exceeds the permissible limit (0.01 mg/l).

Because of low solubility of its compounds and its low geochemical mobility, lead normally occurs in low concentrations in the groundwaters[6]. However, man-made factors can locally raise the lead values in the groundwater, main sources being paints, pigments, ceramics, batteries and smeltaries. Much higher concentration occurs near highways and cities due to the combustion of gasoline[7]. Similarly, cadmium is also a geochemically scarce element. Cadmium chloride complexes are highly mobile and persistent and may be important in waters when they have chloride content above 350 mg/l (ref. 6).

In the study area, the sample nos. 11 to 17, 20 and 21 show higher concentration of Pb and Cd. These samples are from the wells located in the old city blocks, especially in the vicinity of sewerages. There are many small-scale industries such as paints, pigments, storage batteries, ceramics, metal planting, etc., and a few large-scale industries such as textiles and spinning mills. The waste water from these industries and the domestic waste are discharged into the open natural drainages which traverse the whole city. Hence the reasons for the high concentrations of Pb and Cd in the groundwaters of the study area are the effect of sewage/contaminated water, the important sources being the industries mentioned above. However, high concentration of lead may also be attributable to effect of combustion of gasoline[7] and due to the high uptake capacity of montmorillonite group of clay minerals present in the rock formation[8]. The industrial sources responsible for the high concentration of lead and cadmium in the groundwater of different areas are also advocated by earlier workers[9–12].

Lead and cadmium are both toxic to the human body if they exceed the prescribed limits. For cadmium,

Table 1. Concentrations (mg/l) of trace elements in groundwaters of Hubli city

Sample	Fe	Mn	Cu	Ni	Zn	Pb	Cd
1.	0.794	0.020	0.004	0.015	0.222	0.120	0.009
2.	0.202	0.018	0.001	0.022	0.124	0.108	0.004
3.	0.071	0.001	0.011	0.021	0.115	0.080	0.007
4.	0.122	0.009	0.007	0.022	0.115	0.103	0.011
5.	1.136	0.041	0.002	0.029	0.175	0.100	0.011
6.	0.149	0.028	0.000	0.017	0.085	0.067	0.006
7.	0.133	0.176	0.005	0.016	0.109	0.082	0.007
8.	0.343	0.031	0.010	0.019	0.968	0.091	0.008
9.	0.118	0.034	0.008	0.018	0.154	0.103	0.011
10.	0.052	0.020	0.026	0.023	0.196	0.075	0.009
11.	0.076	0.027	0.018	0.032	0.374	0.141	0.012
12.	0.917	0.021	0.001	0.032	0.163	0.118	0.012
13.	0.084	0.029	0.003	0.039	0.424	0.134	0.017
14.	0.121	0.044	0.009	0.023	0.179	0.094	0.009
15.	0.112	0.022	0.014	0.047	0.327	0.178	0.019
16.	0.074	0.013	0.001	0.032	0 101	0.107	0.010
17.	0.093	0.015	0.007	0.045	0.134	0.219	0.019
18.	0.403	0.015	0.017	0.024	0.255	0.080	0.009
19.	0.396	0.009	0.005	0.025	0.118	0.149	0.006
20.	0.075	0.028	0.003	0.032	0.148	0.115	0.013
21.	0.514	0.022	0.001	0.028	0.098	0.868	0.009
22.	0.169	0.013	0.001	0.027	0.261	0.086	0.009

Table 2. Quality comparison of groundwaters of Hubli city with drinking water standards

	WHO (1971) standards		ISI (1983) standards		Number of samples exceeding permissible limits
Trace element	Highest desirable	Maximum permissible	Highest desirable	Maximum permissible	
Fe	0.05	1.5	0.3	1.0	Nil
Mn	0.10	1.0	0.1	0.5	Nil
Cu	0.05	1.5	0.05	1.5	Nil
Zn	5.0	15.0	5.0	15.0	Nil
Pb	–	0.1	0.1	No relaxation	13
Cd	–	0.01	0.01	No relaxation	9
Ni	No prescribed limits				

the target organs of toxicity are kidney, mucus membranes and central nervous system, and for lead, erythropoietic system and unstriated muscles[13].

Since it is the first time the presence of lead and cadmium in the groundwaters of Hubli city is reported an immediate quality monitoring of groundwater in this area is suggested to know the trend and degree of groundwater quality deterioration, which enables one to take precautionary measures to overcome future hazards.

1. Hegde, S. N. and Puranik, S. C., Proc. VII Convention of IGC and Nat. Sem., Dec. 1989–Jan 1990 (in press).
2. Hedge, S. N., Puranik, S. C. and Abbi, A. K., *Ind. J. Environ. Health*, 1991 (submitted).
3. APHA-AWWA-WPCF, 15th edn., American Public Health Association, Washington, DC, USA, 1980.
4. *International standards for drinking water*, World Health Organization, Geneva, 1971.
5. Indian standard specification for drinking water, IS-10500, Indian Standards Institute, New Delhi, 1983.
6. Matthess, G., *The Properties of Groundwater*, Wiley, New York, 1982.
7. Moore, J. W. and Ramamoorthy, S., *Heavy Metals in Natural Waters*, Springer, New York, 1984.
8. Griffin, R. A. and Shimp, N. F., *Env. Sci. Tech.*, 1976. 10, 1256.
9. Pellegrini, M. and Zavatti, A., 'Aquifer contamination and protection', Studies and reports in hydrogeology-30, UNESCO, 1980, pp. 305–309.
10. Ku, H. F. H., 'Aquifer contamination and protection', Studies and reports in hydrogeology-30, UNESCO, 1980, pp. 310–317.
11. Handa, B. K., Kumar, A., Goel, D. K., Bhatia, S. S. and Sondhi, T. N., Abstracts of Seminar on Hydrology, Hissar, 1985, pp. IV–5.
12. Subba Rao, N. and Krishna Rao, G., *Geophys. Res. Bull.*, 1988, 26, 140.
13. Kemper, F. H. and Bertram, H. P., *Nat. Res. Develop.*, 1990, 32, 66.

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Regeneration and transformation of *Nasturtium indicum*: a wild crucifer

Sudip K. Ghosh, Nrisingha Dey, Somnath Bhattacharya and R. K. Mandal

Department of Biochemistry, Bose Institute (centenary building), Calcutta 700 054, India

***Nasturtium indicum* DC (*cruciferae*) is a common weed growing in India. It was successfully and reproducibly regenerated from leaf explants. When transferred to soil the regenerated plants looked morphologically normal and bore flowers and seeds. When leaf discs were cocultivated with an engineered *Agrobacterium* T$_i$ plasmid vector containing plant expressable kanamycin resistance gene as a selection marker and glucuronidase (GUS) gene as reporter, transformed plants were produced. This tropical crucifer weed can be used as a model plant in studies related to the improvement of oilseed mustard by modern biotechnology.**

RAPESEED mustard is grown as an important oil seed crop in the Indian subcontinent and some other countries of Asia, Europe and North America. Mustard seed is not only a source of oil but also a rich source of protein, and the seed meal after extraction of oil can provide nutrient proteins for food and feed purpose[1]. With a view to improving oil seed mustard using modern biotechnology, work has been initiated in this laboratory, on the isolation of genes expressed in seeds and the analysis of their regulatory sequences[2,3]. We use tobacco as a model plant for the analysis of function of mustard seed protein gene regulatory domains. However, tobacco being a plant that takes long duration from seed sowing to maturation, the experiments take more than a year from tissue culture transformation to maturing seed. The experimental favourite is *Arabidopsis thaliana* because of its short life cycle, small plant size, small genome size and much of its genetics being known[4]. However, being a temperate plant, it cannot be maintained in open environment in warm tropical climate. Moreover, in tissue culture or pot culture, *Arabidopsis* does not grow and set seeds properly above a temperature of 20°C, a condition which is expensive in tropical countries.

While searching for a suitable tropical alternative model of oil seed *Brassica*, we picked up *Nasturtium indicum* DC, commonly known as water cress (syn. *Rorippa montana* Small), which grows readily in Indian climatic condition almost throughout the year. Though the growth is more vigorous in moderate winter, the plant has been observed to grow well even in summer months in partially shaded areas when maximum temperature rises up to 38°C. Its seeds are tiny (1000 seeds, weight 59 mg) and a large number of seeds can be collected for analysis from individual plant. The seeds were analysed for total protein and oil content and were found to contain 21.4% protein and 42.2% oil on the basis of seed dry weight, values being close to mustard[1]. The plant is photoperiod insensitive so that it flowers throughout the year. The haploid DNA content (C value) as measured by cytophotometry after Feulgen staining[5] was found to be 1.4 pg, compared to 1.5 pg in tetraploid *Brassica juncea*. The growth duration from germination to mature seeds is 2–3 months depending on the season. Thus *Nasturtium* resembles cultivated *Brassica* in many ways and having some advantages as mentioned, it can be used as a model plant for expressing mustard genes.

Seeds were collected from the *Nasturtium* weeds