HEALTH IMPACTS OF MERCURY CYCLING IN CONTAMINATED ENVIRONMENTS OF CENTRAL INDIA STUDIED BY NAA AND ICP-MS

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Abstract

The environmental and atmospheric samples i.e. surface water, ground water, surface soil, sediment, rain and fog from various sites of contaminated environments of central India were collected in year, 2000-2001. The concentration levels of total-Hg in these samples were analyzed by using techniques i.e. cold vapor- atomic absorption spectrophotometer (CV-AAS), X-ray fluorescence spectrophotometer (XFS). Further, the data base of total Hg in the environmental samples would be validated in other laboratories i.e. Prof. Dr. Klaus Heumann (Johannes Gutenberg-University, Mainz, Germany), David Amouroux (University of Pau, France) and Dr Joerg Feldmann (University of Aberdeen, Scotland, UK) for exploration of the Hg-contaminated environments by using techniques i.e. ICP-MS/GC, gas chromatography-induced couple atomic emission spectrophotometer (GC-ICP-AES), neutron activation analysis (NAA).

1. METHODOLOGY

The environmental and atmospheric samples were collected and prepared by using the established approaches and methodologies. The liquid samples i.e. rain, water were collected and immediately acidify with few drops of ultra pure nitric acids. The solid samples i.e. soil, sediments were collected and dried up to 40°C. They were crushed and sieved out to separate particles of mesh size < 100 μm. The solid samples were digested with aqua-regia under controlled temperature in a sealed tube. The technique i.e CV-AAS was used for monitoring of the total Hg. The data would be validated by using sophisticated techniques i.e. ICP-MS/ GC-AF, ESI-MS, etc.

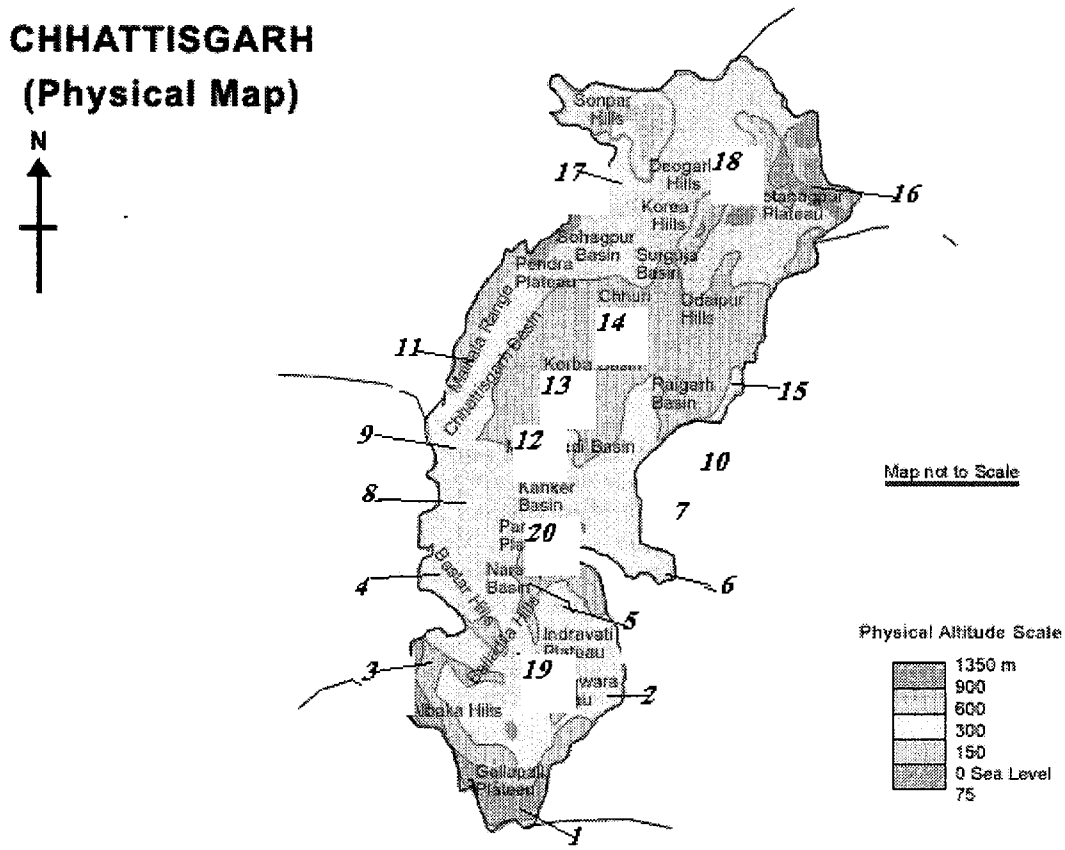

FIG 1: Presentation of sampling sites in CG state of India

No	Site	No	Site	No	Site
1	Kota	8	Gariyaband	15	Raigarh
2	Jagadlpur	9	Rajnandgaon	16	Jaspurnagar
3	Bhopalpatnam	10	Chowki	17	Chirmiri
4	Manpur	11	Kharagarh	18	Ambikapur
5	Narainpur	12	Raipur	19	Dantewara
6	Devbhog	13	Bilaspur	20	Kanker
7	Nawagarh	14	Korba		

2. RESULTS AND DISCUSSION

The technique i.e. CV-AAS was used for the determination of total concentration of Hg in environmental and atmospheric samples i.e. surface and, ground water, rain, fog, surface soil and sediment samples.

Surface Water:

The stagnant pond waters (n = 20) and mobile river waters(n = 3) were collected in Jan.2000 in Teflon bottles (250 ml). The waters were treated with few drops of ultra pure nitric acid. The mean, median value and range of the total Hg in the stagnant pond waters were found to be 356.4, 395.2 and 45.8 – 779 μg/L with std. dev. of ± 212.5, Table-1. The highest concentration level of the total Hg was recorded in the winter season whereas the lowest concentration in the summer (in month of May, temperature ≈ 47°C) due to evaporation. Similarly, concentration of the total Hg in river water was ranged 19.0 – 163.0 μg/L in the winter, Table-2. The concentration of total Hg was several folds lower in the river water and found to be the highest in the water of iron belt area, Table-3. Mercury in the ground water was also detected in the shallow aquifers, lie near the surface water reservoirs and found to be in the lower micro-gram levels due to diffusion.

TABLE I: CONCENTRATION LEVEL OF TOTAL MERCURY (MG/L) IN STAGNANT SURFACE WATER (TANK/ LAKE) IN WINTER, JAN. 2000

No.	Site	$Hg_{(T)}$	pH	No.	Site	$Hg_{(T)}$	pH
1	Kota	457.6	5.6	11	Kharagarh	55.8	7.3
2	Jagadlpur	385.0	5.1	12	Raipur	578	7.2
3	Bhopalpatnam	591.0	6.0	13	Bilaspur	233.0	7.4
4	Manpur	405.4	5.1	14	Korba	779.0	5.7
5	Narainpur	466.0	5.5	15	Raigarh	174.6	6.8
6	Devbhog	347.0	6.0	16	Jaspurnagar	57.2	7.0
7	Nawagarh	222.0	6.5	17	Chirmiri	483.5	5.5
8	Gariyaband	545.0	6.1	18	Ambikapur	187.7	6.5
9	Rajnandgaon	99.6	7.2	19	Dantewara	594.0	6.3
10	Chowki	45.8	7.0	20	Kanker	421.0	6.6

TABLE II: SEASONAL & SPATIAL VARIATIONS IN CONCENTRATION LEVELS OF TOTAL MERCURY (MG/L) IN STAGNANT SURFACE WATER (TANK/LAKE) IN YEAR, JAN. 2000

Site	Winter	Summer	Rainy
Raipur	578	20.6	36.5
Korba	779	22.9	51.4
Bilaspur	233	15.4	25.6
Kanker	654	31.5	63.2
Jaspurnagar	57.2	24.5	24.0

TABLE III: CONCENTRATION LEVELS OF TOTAL MERCURY (MG/L) IN RIVER WATERS IN WINTER, JAN. 2000

River	Winter	Summer	Rainy
Hasdev	38.0	10.6	14.0
Mahanadi	19.0	10.9	12.4
Indravati	163.0	25.4	45.6

Soils and Sediments:

The surface (0-10 cm) soils (n = 20) and sediments from ponds (n =19) and rivers (n =10) were collected. The concentration of the total Hg in soil samples was ranged from 1.0 - 22.5 mg/kg. In the sediment samples, the concentration of total Hg was found to be in the range of 2.7 –16.7 mg/kg.

TABLE IV: TOTAL HG CONCENTRATION (MG/KG) IN SEDIMENTS, PARTICLE SIZE <0.05 MM

Area	Type	n	Mean	Range
Iron belt	Pond	05	13.4	11.0 –16.7
	River	05	10.0	8.3 – 11.6
Industrial belt	Pond	10	9.2	4.9 – 11.6
	River	04	4.3	2.7 – 5.5
Coal belt	Pond	04	7.5	6.2 – 8.6
	River	01	3.8	3.8

Rain and Fog:

The rain (n = 50) and fog (n = 10) samples were collected using the established procedures. The samples were acidified with few drops of concentrated ultra pure nitric acid. The total concentration levels of Hg was monitored and the volume weighted mean concentration of the total Hg in rain and fog waters was found to be 6.2 and 47 mg/L, respectively.

3. EXPECTED SOURCES

- Smelting of pyrite minerals
- Coal burning
- Leaching from pyrite minerals
- Industrial wastes
- Coming of distant pollutants

4. FUTURE WORK (2002-3)

Monitoring of Hg in human samples i.e. hair, urine, blood.

5. ADDITIONAL SUPPORT

- Alexander von Humboldt Foundation, Bonn, Germany
- Indo-French Center for Promotion of Advanced Research, New Delhi
- Commonwealth Science Council, London, UK