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RAIN WATER CHEMISTRY AND QUALITY IN AND AROUND TWIN CITIES OF HYDERABAD AND SECUNDERABAD, ANDHRA PRADESH, INDIA

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Abstract

The rainwater investigations over the Hyderabad and Secunderabad were carried out to observe the quality of rainwater with regard to influence of marine or non-marine components of atmosphere. 20 rainwater samples from different locations covering an area of 150 Sq.Km. collected and were analyzed for pH, EC, CO_3, HCO_3, SO_4, NO_3 using standard methods, Na, Ca, K and Mg on AAS and trace elements like Pb, Fe, Cr, Cd and As were analyzed on ICP. The concentrations observed maximum for Cl (2.6 ppm) and lowest for Cu (0.0037 ppm) with pH ranging from 6 to 7 and EC from 17 to 53 µMhos/cm. From correlation study and neutralizing factors (NF) calculation for Ca^{2+} and Mg^{2+} it is observed that good correlation exists between H^+ and SO_4 and H^+ and NO_3 suggesting strong affinity between the oxides of sulpher, nitrogen and H^+ ion concentration indicating the influence of non-marine components and neutralizing factors calculations suggests potential acid neutralizing capacity of alkaline elements such as Ca^{2+}, K^+, Mg^{2+}, Na^+ mostly released from granitic soils to atmosphere in the form of dust.

Keywords: Rainwater, Quality, Hyderabad, Secunderabad.

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Metallurgical Research Laboratory (DMRL) and Nuclear Fuel Complex (NFC) at Hyderabad. The analytical results were tabulated in Table 1.

4. Discussion

The components of atmosphere are mainly from two sources, marine and non-marine.To distinguish the marine and non-marine species in atmosphere the sea salt fractions (SSF) and non-sea salt fractions (NSSF) were calculated and data is presented in Table 2 (Kulshresta,et. al, 1996). The role of acid components was calculated from free acidity ratios H^+/SO_4 and H^+/NO_3. The alkaline component contribution to the atmosphere through neutralizing factors (NF) for Ca and Mg was also calculated.

The decreasing mean concentration of the chemical parameters analysed are Cl (2.6), NO_3 (1.8), HCO_3 (1.5), SO_4 (1.5), NO_3 (0.9), Ca (0.8), K (0.3), Pb (0.008), B (0.0075), and Cu (0.0037). The pH is between 6 to 7 with an average of 6.340, and EC

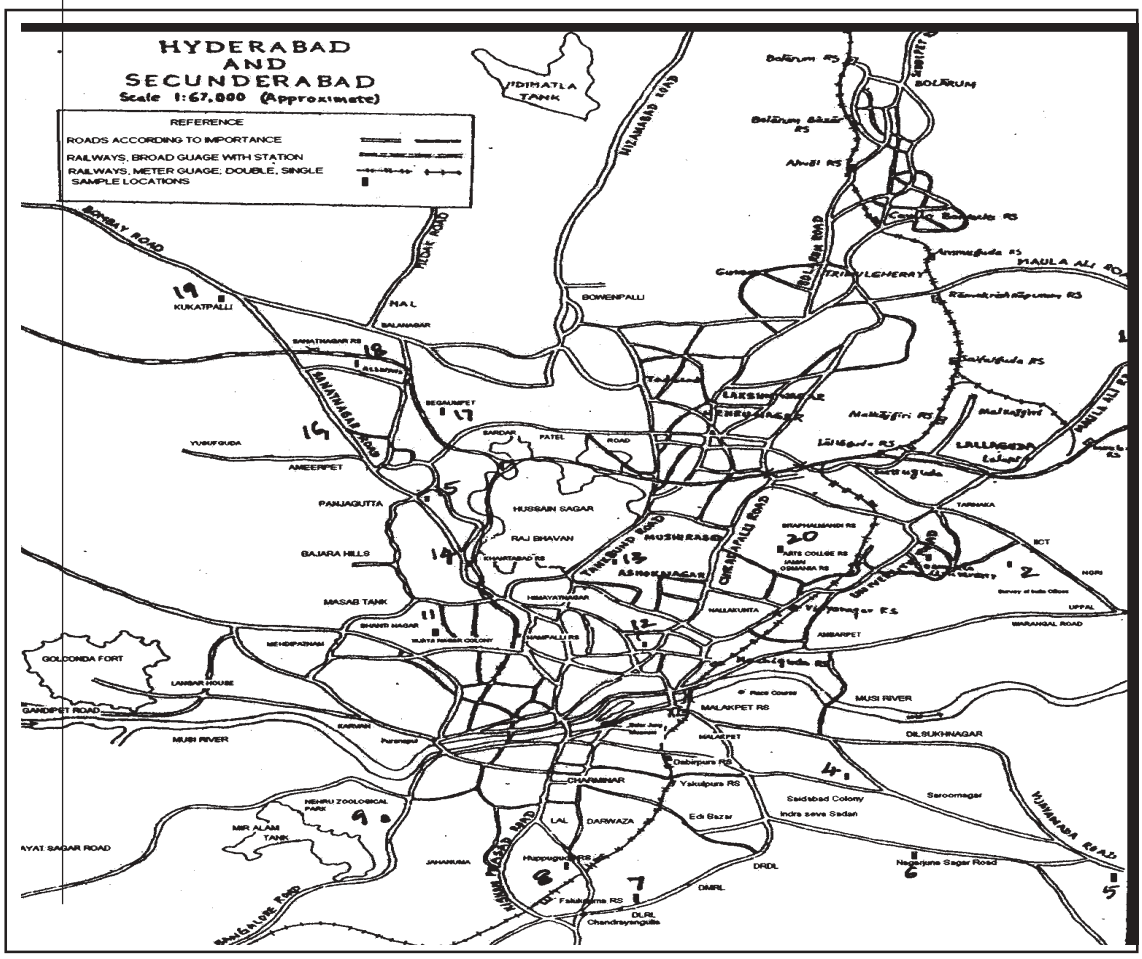

Fig. 1. Rain water sample locations with details.

1. ECIL	2. Habshiguda	3. Ghatkesar	4. Saidabad
5. Vanasthalipuram	6. Karmanghat	7. Kanchan Bagh	8. Sultanshai
9. Bahadurpura	10. Chilkur	11. V.N. Colony	12. Ramkote
13. Domalguda	14. Khairtabad	15. Panjagutta	16. Vengalraonagar
17. Begumpet	18. Sanathnagar	19. Kukatpally	20. Ramnagar

Table 1. The mean, minimum and maximum concentrations of the analyzed species. (in ppm).

Species	Minimum	Maximum	Mean
pH	6.0	7.00	6.34
Cl	1.6	3.40	2.60
Ca	0.60	1.05	0.81
Mg	0.20	0.28	0.24
SO_4	0.73	2.30	1.45
NO_3	0.85	2.60	1.80
Ec	17.00	53.00	37.80
HCO_3	1.00	1.86	1.50
Pb	0.005	0.013	0.008
Na	0.64	1.30	0.879
K	0.23	0.40	0.301
Cu	0.003	0.006	0.004
Zn	0.008	0.002	0.012
B	0.003	0.016	0.008
Cd, Ag, As, Ni, Cr <0.01			

Table 2. The acidic and alkaline components in the wet precipitation.

	Minimum	Maximum	Average
H^+/SO_4	0.007	0.026	0.016
H^+/NO_3	0.007	0.025	0.0169
Neutralizing Factor (Ca)	0.358	0.774	0.481
Neutralizing Factor (Mg)	0.149	0.502	0.244
NSSF (Ca)	94.71	97.25	95.85
NSSF (K)	86.51	91.82	89.17
NSSF (Mg)	39.15	68.12	56.30
NSSF (Cl)	16.95	61.07	39.53
NSSF (SO_4)	72.09	91.74	82.69

ranges from 17 to 53 µMhos/cm with an average of 37.8.

The acid and alkaline parameters in the rain water in the order of decreasing average values as NSSF (Non-Sea Salt Fraction) are Ca (95.85), K (89.17), SO_4 (82.69), Mg (56.30) and Cl (39.53), neutralizing factor for Ca (0.481), Mg (0.244), H^+/NO_3 (0.0169), H^+/SO_4 (0.0162) (Table 2). The process of precipitation is explained by the potential acid neutralizing capacity of alkaline elements such as Ca^{2+}, K^+, Mg^{2+}, and Na^+ mostly released in the form of dust and transmitted to atmosphere from granitic soils (Charslon and Rodhe, 1982; Edward, 1985). The alkaline dust reacts and neutralizes the acids in the atmosphere (Khemani et.al.,1985, Srinivas et.al., 2001).The values of NF (Neutralization Factor) for Ca and Mg (Table 2) substantiate the above fact about the role of alkaline elements in neutralizing the acidic components in the atmosphere (Srinivas, 1999). The

neutralizing factor of an element indicates the concentration and abundance of that element in nature. More the NF more the soils are exposed to the sky. The absence of any neutralizing elements, the pH of the precipitation would have been alarmingly low, and is a welcome sign for the acid rains. A study of water-soluble aerosols in different environments of India (Khemani et. al., 1987b) has shown that the atmospheric aerosols in India are rich in soil oriented basic ions. The low concentrations of Ca^{2+} in rainwater reported from western countries are the major cause of acid rain (Stensland and Semonim, 1982, Munger, 1982).

$$\textit{percentage of Sea Salt Fraction (SSF)} = \frac{100\ (Na)\ (X/_{Na})_{sea}}{X}$$

X is the component of interest

Percentage of Non Sea Salt Fraction (NSSF)=100-SSF

$$\textit{Neutralisaction Factor (NF) for Ca} = \frac{Ca}{2NO_3 + SO_4}$$

$$\text{Neutralisaction Factor (NF) for Mg} = \frac{Mg}{2NO_3 + SO_4}$$

In order to see the affinity of elements with each other correlation studies were carried out. The best correlation to poor correlation is as follows: Cl-NO_3 (0.90), Pb-HCO_3 (0.86), NO_3-HCO_3 (O.75), Pb-NO_3 (0.75), Ca-SO_4 (0.73), Cl-SO_4 (0.71), Cl-Pb (0.71), Ca-Pb (0.66), SO_4-NO_3 (0.65), SO_4-HCO_3 (0.62), and Cl-Na (0.61).

The correlation between H^+ and other parameters in the order of decreasing correlation are: H^+-EC (0.86), H^+-NO_3 (0.80), H^+-Pb (0.79), H^+-SO_4 (0.62) and H^+-HCO_3 (0.79). The good correlation between EC and other parameters in decreasing order of correlation is as follows: EC-H^+ (0.85), EC-Cl (0.85), EC-NO_3 (0.84), EC-Pb (0,83), EC-SO_4 (0.81) and EC-Ca (0.78) (Table 3).

The correlation between H^+ and SO_4 and H^+ and HNO_3 indicate strong relation between the oxides of sulfur, nitrogen and H^+ ion concentration. The free acidity ratios H^+/SO_4 (average = 0.0162), H^+/NO_3 (average = 0.0169) together with correlation (r) values testify a significant contribution by the oxides of sulfur and nitrogen for the rise of H^+ ion concentrations.

Table 3. Table Showing the correlation of elements

	H^+	Cl	Ca	Mg	B	Pb	Cu	Zn	Na	K	SO_4	NO_3	Ec	HCO_3
H^+	1.00	0.73	0.56	0.19	0.41	0.79	-0.20	-0.51	0.23	-0.21	0.62	0.80	0.86	0.79
Cl		1.00	0.57	0.27	0.53	0.71	-0.30	-0.63	0.61	0.088	0.71	0.90	0.85	0.77
Ca			1.00	0.43	0.23	0.66	-0.09	-0.19	0.55	0.26	0.72	0.58	0.80	0.55
Mg				1.00	0.55	0.32	-0.48	0.22	0.26	0.27	0.26	0.04	0.37	0.26
B					1.00	0.42	-0.35	-0.21	0.18	-0.05	0.32	0.38	0.52	0.64
Pb						1.00	-0.33	-0.47	0.45	0.07	0.48	0.75	0.83	0.86
Cu							1.00	-0.04	-0.17	-0.09	-0.12	-0.06	-0.30	-0.23
Zn								1.00	-0.13	0.30	-0.41	-0.63	-0.46	-0.58
Na									1.00	0.68	0.35	0.52	0.48	0.39
K										1.00	0.02	-0.004	0.03	0.03
SO_4											1.00	0.65	0.81	0.62
NO_3												1.00	0.84	0.75
Ec													1.00	0.85
HCO_3														1.00

Lead and nitrate with r = 0.75 indicate that both are of same source. The oxides of nitrogen are released by the burning of liquid fuel from vehicles. Lead in the precipitation has its presence from leaded petrol burnt by the vehicles. The compound of lead (tetraethyl lead) is used as good antiknocking agent, could be the source of lead in the atmosphere (Wadepohl, 1978). Most of the sulphate (average=82.69) is of non-marine origin (Table 2) indicating sulphate is essentially from anthropogenic sources, industries of fossil fuels.

5. Conclusions

The following conclusion can be made:

1.There is a good correlation between H^+ and SO_4 and H^+ and NO_3 suggesting a strong relation between the oxides of sulpher, nitrogen and H^+ ion concentration. They have higher concentration at places of heavy vehicular traffic.

2.The free acidity ratios H^+/H_2SO_4 (average = 0.0162), H^+/HNO_3 (average = 0.0169) together with good correlation (r) values testify a significant contribution by the oxides of sulpher and nitrogen for the increase of H^+ ion concentration.

3. Lead and nitrate with r = 0.75 indicate that both are from same origin or source. This can be attributed to the vehicular traffic.

4. The studies suggest that the alkali metals Ca^{2+}, K^+, Mg^{2+}, Na^+ in the atmosphere derived from granitic soils and transmitted to atmosphere, neutralize the acids, and prevent the commencement of the acid rains.

5. Most of the sulphate (SO_4) is of non marine origin and is attributed to anthropogenic sources such as industries, burning of fossil fuels etc,

6.The increase or decrease of neutralizing factor indicates the abundance or paucity of that element and the extent of exposure of soils to the sky.

7.Lastly at present there is no threat of acid rain but at certain junctions like Koti, Abids, Punjagutta, Liberty, Secunderabad and Hyderabad Railway stations may be prone to acid rains in future due lack of soil exposure to the sky.

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