International Journal of Innovative Research and Advanced Studies (IJIRAS)
Volume 4 Issue 7, July 2017
ISSN: 2394-4404

Analysis Of Water Chemistry Of Iron Belt Of Barbil , Odisha To Compare Between The Direct Contribution To The Contamination Of Water By Mining And Industries With The Indirect Addition To The Contamination By The Wash Out From The Area

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***Abstract:** Most of the water bodies are presently contaminated to alarming proportions due to anthropogenic interventions such as mining and industrial activities. The fresh water for human consumption is limited. Hence, assesment and monitoring of various sources of such contamination are absolutely necessary. Barbil is chosen as study area for such purpose. This area is well known for mining and industrial activities. Samples were collected from these areas and analysed in the laboratory through conventional techniques for determining the cations, anions and heavy metals present in water samples. Factor analysis of geochemical data of post monsoon water samples is carried out for revealing the hydrochemical characteristics of water of the area. Wash outs from industrial and mining wastes plays a major role in the chemistry of water as brought out by factor analysis.*

***Keywords:** Surface water, Post-monsoon, Barbil, Factor analysis, Hydrochemistry*

I. INTRODUCTION

The chemistry of water is a cumulative reflection of catchment geology, rainfall, erosion processeses and anthropogenic interventions. Physical and chemical weathering along with erosion operate incessantly over earth surface. The chemical processes in weathering are mainly chemical degradation of silicate minerals by various processes like dissociation, hydrolysis, oxidation and reduction. The result of chemical processes are various ions and clay minerals. The natural processes of weathering and erosion is increased by anthropogenic activity such as mining. Keeping these objectives in mine water samples were collected from Bolani and Barbil for assessing the impact of mining and industrial activity of the region on surrounding water bodies (Fig.1).

II. OBJECTIVE OF THE STUDY

There is a popular discussion among every one today regarding impact of mining and industry on the water bodies in the mining area and industrial area .Scientific knowledge puts emphasis on the factor that wash out from mining and industrial area cause severe damage .Amidst the large scale on going notion we intended to arrive at a conclusion on exactly which factor contributes higher to the contamination of water bodies. Whether it is directly by mining and industries or it is the wash out from the mining and industrial area .The detailed study was to reveal the higher contribution factor for contamination of the water bodies in the study area.

III. LOCATION OF THE STUDY AREA

The study area lies in between 22° 03' to 22° 08' north latitude and 85° 18' to 85° 25' east longitudes of Keonjhar district. The area enjoys a humid-tropical climate and Karo river is the main river of the area which rises in Bonai hills and flows towards Singhbhum district of Bihar through Bolani and Barbil. Bolani and Barbil are known for their iron and manganese deposits. Rocks of the area belong to Iron Ore Group (IOG) comprising mainly Banded Iron Formation (BIF) and associated volcano-sedimentary rocks. Samples were collected during 2012 to 2013.

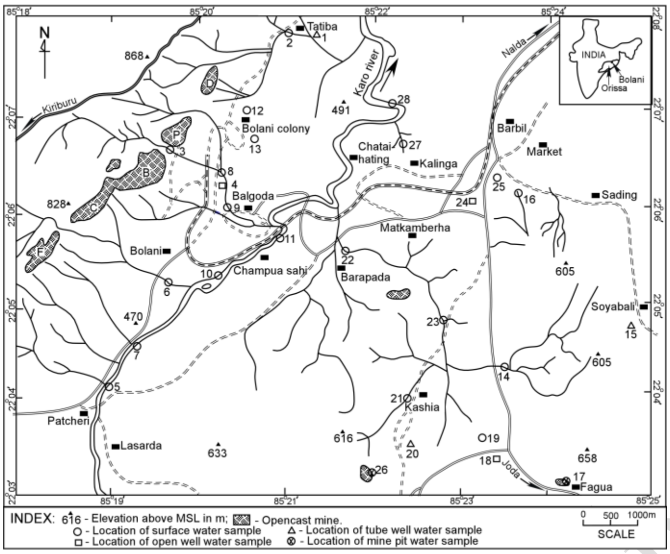

Figure 1: Location map of water samples

IV. MATERIALS AND METHODS

Sampling area was necessary for us before assigning a particular source to a particular group in order to understand whether that source is existing or not or else an alternative interpretation has to be made for the group considered. 50 Number of samples were collected and chemically analysed at the laborartory for interpretation by results.

At the background of survey a detailed knowledge regarding the geology of the area such as ground water and surface water condition, weathering conditions, rock types of the area etc were taken in to account for cross checking the results with our theoretical knowledge.

The following methods were used for chemical analysis of the samples.

A. FLAME PHOTOMETER METHOD FOR DETERMINATION OF CONCENTRATION OF SODIUM AND POTASSIUM

The concentration of sodium and potassium were determined by flame photometer (Elico - Model CL22D) using particular filter for the wavelength of particular element. Calibration curves were made with various standard solutions and then the concentration of test water samples were obtained.

B. ATOMIC ABSORPTION SPECTROPHOTOMETER METHOD, VOLHARD'S TITRATION METHOD AND REDUCTION METHOD FOR DETERMINATION OF QUANTITY

Calcium and magnesium were determined by Atomic Absorption Spectrophotometer (Perkin Elmer-3100) taking suitable dilutions. Chloride was estimated by Volhard's titration method (Vogel, 1968). Nitrate was determined by cadmium reduction method (U.S.E.P.A., 1979). Total alkalinity is determined by titration with a standard solution of strong acid using phenolphthalein and methyle orange indicator (Jenkins and Moore, 1977) to the end point of pH 4.5.

C. TITRATION METHOD

Total hardness of the water was determined by complexometric titration with EDTA. EDTA acts as a complexing reagent, which forms soluble complexes with metal ions like Ca^{++} and Mg^{++}. Since Ca/Mg – EDTA complexes are stable at pH 8-10, the pH of the solution during the titration was maintained at 10 by adding a suitable buffer like NH_4OH solution using eriochrome black T, as indicator. If the sample does not contain sufficient magnesium ions, then Mg-EDTA complex is added to the titration flask to provide a sharp colour change at the end point (wine red to pure blue). Hardness of water is expressed in terms of mg of $CaCO_3$ per litre.

D. HEAVY METAL DETECTION

Ions present in water have of low concentration of metal. It was necessary to enrich the analyse by a physical or chemical process before instrumental analysis. For this non-boiling method for pre-concentration of heavy metals from the water samples is used for the present study. 250ml of sample was taken in a conical flask and evaporated in an electric oven to a temperature of 70°C ± 5°C. Few drops of HNO_3 were added to it and final volume was made up to 25ml (concentrated to 10 times). These samples were used for heavy metal detection. The concentration of Fe, Mn, Cu, Ni, Co, Zn, Pb, Cr were determined by an Atomic Absorption Spectrophotometer (Perkin Elmer-3100) with a setting of different wavelengths for different elements using hollow cathode lamp and directly aspirating the pre-concentrated sample into air acetylene flame.

E. FACTOR ANALYSIS

The chemical data are subjected to factor analysis. Factor analysis is a useful explanatory tool in multivariate statistical analysis and it can be applied to discover and interpret relations among variables including samples or to test hypotheses. The general purpose of factor analysis technique is to find a way of condensing the information contained in a number of original variables into a smaller set of new composite dimensions with minimum loss of information. Depending upon the objective of the problem, one can perform R-mode factor analysis, which extracts relations

ISSN: 2394-4404

between variables or Q-mode factor analysis which extracts clusters of samples.

V. RESULT AND DISCUSSION

The following factors were determined and interpreted as a result of our detailed studies, sampling and chemical analysis and interpretation of the results.

Factor-1: This factor explains about 28.526% of total variance. This is loaded in favour of pH-EC-TSS-TDS-TS-Alkalinity-Hardness-Cl-SO_4-Ca-Mg-Na-K-Cu.This factor can be interpreted as conductivity factor. This factor measures conductivity, alkalinity and hardness. This factor may be attributed to leaching of soils and rocks of the area and higher dissolved CO_2 in post-monsoon water. Presence of Ca, Mg, Na, K may be from mine and industrial wastes of the region.

parameter	unit	range	mean	parameter	unit	range	mean
pH		6.2-8.5	7.4	Ca	mg/l	0.473-31.4	6.78
EC	µmho/cm	25-195	91.85	Mg	mg/l	1.10-17.642	6.027
TSS	mg/l	3-760	250.2	Na	mg/l	0.58-9.15	2.07
TDS	mg/l	16-125	58.35	K	mg/l	0.090-2.85	1.28
TS	mg/l	19-825	309.05	Fe	µg/l	70-2300	873
Turbidity	NTU	0.7-227.8	32.89	Mn	µg/l	10-500	83
Alkalinity(t)	mg (CaCO$_3$)	41.2-143.2	78	Cu	µg/l	10-390	102
Hardness	mg/l	2.1-130.2	38.35	Zn	µg/l	10-80.0	19
Cl^-	mg/l	0.6-7	1.9	Ni	µg/l	10-40.0	23
$SO_4^=$	mg/l	o.86-2.87	1.02	Co	µg/l	10-90.0	50
NO_2^-	mg/l	0.004-0.575	0.125	Cr	µg/l	100-350	150
$NO_3^=$	mg/l	0.031-2.54	0.595	Pb	µg/l	10-170	78
$PO_4^=$	mg/l	0.002-0.029	0.009				

Table 1: Geochemical data of post- monsoon water of Bolani and Barbil

Factor 2: This factor explains about 9.239% of total variance. This is loaded positively on NO_2-NO_3-PO_4 and can be interpreted as nutrient factor, which may be due to leaching from soils.

Factor 3: This factor explains about 8.81% of total variance. This is positively loaded on Fe-Mn and negatively loaded on PO_4. This factor can be attributed to mining iron and manganese in the area and can be expressed as mining factor.

Factor 4: This factor explains about 8.27% of total variance. This factor is negatively loaded on TSS-TS-Turbidity and can be expressed as turbidity factor which may be due to wash outs of surrounding region due to rainfall.

Factor 5: This factor explains about 8.14% of total variance. This factor is positively loaded in favour of Ni and negatively loaded on Pb. This factor suggests contamination by washed out water from overburden dumps along with atmospheric fallouts from vehicular emissions.

Factor 6: This factor explains about 7.34% of total variance. This factor is positively loaded on Zn and negatively loaded on pH-K. This factor suggests the adsorption of Zn by clay minerals.

Factor 7: This factor explains about 7.12% of total variance. This factor is positively loaded in favour of Mg-Na and negatively loaded on Cr. This factor may be attributed to leaching from host rock. Also, this factor suggests the adsorption of Cr by Mg-Na rich clay minerals.

Variables	Factor-1	Factor-2	Factor-3	Factor-4	Factor-5	Factor-6	Factor-7	Factor-8	Communality
pH	**0.531**	-0.178	-0.198	**-0.457**	0.250	-0.008	0.246	-0.151	0.707
EC	**0.963**	0.092	0.087	0.002	-0.086	0.003	-0.054	-0.049	0.955
TSS	**0.509**	0.151	-0.022	-0.212	-0.097	0.143	0.110	**-0.717**	0.884
TDS	**0.917**	0.064	0.031	-0.063	-0.067	0.022	-0.126	-0.227	0.921
TS	**0.596**	0.165	0.019	-0.165	-0.072	0.178	0.110	**-0.664**	0.900
Turbidity	0.047	-0.148	-0.032	0.232	0.103	-0.012	-0.249	**-0.822**	0.827
Alkalinity	**0.864**	0.041	-0.122	-0.088	-0.144	0.117	0.047	-0.131	0.824
Hardness	**0.880**	-0.005	0.221	-0.175	0.144	-0.105	-0.119	0.070	0.905
Cl^-	**0.799**	0.297	0.202	0.178	-0.140	-0.146	-0.184	-0.135	0.892
$SO_4^=$	**0.490**	0.298	-0.027	0.133	-0.353	0.124	**0.504**	0.033	0.743
NO_2^-	0.211	**0.890**	-0.053	-0.066	-0.158	0.006	-0.019	-0.061	0.873
$NO_3^=$	0.012	**0.936**	-0.033	-0.002	0.148	-0.129	0.061	0.084	0.927
$PO_4^=$	0.147	**0.471**	0.156	0.243	-0.091	**-0.601**	-0.098	-0.259	0.773
Ca	**0.862**	0.031	-0.003	0.112	0.057	0.086	0.051	-0.155	0.794
Mg	**0.513**	-0.040	0.437	-0.118	0.358	-0.410	-0.264	0.201	0.875
Na	**0.574**	0.017	**0.458**	-0.130	-0.187	0.108	-0.445	-0.198	0.840
K	**0.516**	0.045	0.336	**-0.535**	-0.201	0.253	-0.099	-0.205	0.822
Fe	0.228	-0.038	0.073	0.168	-0.167	**0.847**	-0.088	-0.096	0.849
Mn	-0.055	-0.033	0.193	-0.114	0.298	**0.767**	-0.272	-0.153	0.829
Cu	**0.520**	0.279	-0.308	-0.087	-0.321	0.267	0.044	-0.189	0.662
Zn	0.018	-0.043	0.179	**0.917**	0.066	0.043	0.067	-0.092	0.894
Ni	-0.008	-0.096	-0.229	0.212	**0.841**	0.041	-0.126	-0.076	0.837
Co	0.188	0.033	-0.173	-0.003	-0.025	0.241	**-0.760**	-0.074	0.708
Cr	-0.113	0.074	**-0.818**	-0.239	-0.001	-0.133	-0.177	-0.022	0.794
Pb	0.163	-0.150	-0.407	0.163	**-0.747**	-0.065	-0.210	-0.086	0.854
Eigen values	7.132	2.310	1.782	1.837	2.035	2.203	1.521	2.068	
% of trace	28.526	9.239	7.129	7.347	8.140	8.813	6.083	8.272	
Cummulative % of trace	28.526	37.766	44.894	52.241	60.382	69.194	75.277	83.549	

Table 2: Varimax rotated R-mode factor loading matrix for geochemical data of post- monsoon water samples. Bold values are significant at 95% level of confidance (N= 28)

Factor 8: This factor explains about 6.083% of total variance. This factor is positively loaded on SO_4 and negatively loaded on Na-Co. Loadings on SO_4 indicate atmospheric fall outs from coal burning in the iron industry of the area and can be interpreted as the sulphate factor.

VI. CONCLUSION

Contribution of factors due to mining and industrial operation directly played a minor role. Where as it was important to note that factor analysis of geochemical data of post-monsoon water samples of the area revealed that wash outs from mine and industrial wastes play a major role in controlling the water chemistry in post-monsoon period. Hence, preventing measures such as stabilisation of slopes of mine and industrial dumps, afforestation, preservation of top soils, utilization of ore fines are necessary for minimizing contamination of water bodies of the region.

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