Hydrochemistry of Coal Mine Water from Sohagpur area of Shahdol District, Madhya Pradesh, India

*Deepika Rathore[1], K.N. Singh[2]

Author's Affiliations:
[1,2]School of Studies in Earth Science, Vikram University, Ujjain, Madhya Pradesh 456010, India.

Corresponding Author: Deepika Rathore, School of Studies in Earth Science, Vikram University, Ujjain, Madhya Pradesh 456010, India.
E-mail: rathoredeepika11@gmail.com

How to cite this article: Rathore, D. & Singh, K.N. (2021). Hydrochemistry of Coal Mine Water from Sohagpur area of Shahdol District, Madhya Pradesh, India. *Bulletin of Pure and Applied Sciences-Geology,* 40F(2), 288-294.

ABSTRACT

The quality of water in mines is a major issue of concern for our whole world. The present research work focused on quality assessment of coal mine water, based on water chemistry from different mines of Sohagpur area. Water chemistry includes physical and chemical parameters of water, which is directly related to elements and mineral components of water. Mineral components directly or indirectly influences to our environment. The main 14 parameters are used i.e., pH, Conductivity, Turbidity, TDS, Total Alkalinity, Total Hardness, Chloride, Fluoride, Ammonia, Iron, Nitrate, Na, K, Ca. The highest value of Conductivity (13000 µS/cm), turbidity (15.9 NTU) and TDS (1370 mg/l) is found in L8 and the highest value of fluoride found in L6 and L9 (1.7 mg/l). The highest pollution level was found in the water of Amlai Opencast Mine (L8) and the other water samples for Drinking and Mine Water of Dhanpuri Opencast Mine (L6 and L9) can be used after small treatment. After complete the analysis of coal mine water samples, we are concluding that the water running across the mines are mostly affected by mining activities.

KEYWORDS: *Physico-chemical parameter, Coal mines, Sump, Assessment, Environmental impacts.*

INTRODUCTION

Coal is worldwide distributed fossil fuel and it is expected to be essential component of the world energy resource for the foreseeable fuel. Coal gives 30.3% of universal primary energy requirements and generates 42% of world electricity (IEA-2012). The exploration of coal gives rise to various kind of pollution like water, air and noise pollution. Mineral components directly and indirectly influences to our environment and human as well. The environmental problem is associated with mine working throughout the process from exploration to beneficiation and processing. In India, where mining has been an established industry for centuries; effort towards the control and presentation of mining associated environmental impacts have not been noteworthy. The mining sector is the environmental non friendly endeavor. Water is one of the most abundant commodities in nature. Clean water is essential for life and over two million people dying from water related disease every year. The contamination of water is directly related to the degree of

contamination of our environment. Mine water collects impurities from discharged mine effluent and seepage from tailings and waste rock impoundments. Number of studies based on water contamination in coal mines have been done but limited amount of data is available in the form of literature. Hence, the main objective of this research paper is to assess the quality of mine water of the studied area. The present research work focused on environmental impacts of coal mines, based on water chemistry from Sohagpur area. Which includes physical and chemical analysis of water that is directly related to elements and mineral components of water.

MATERIALS AND METHODS

Description of study area

The Sohagpur Coalfield is the major coal producing area of South Rewa Gondwana Basin. Amlai opencast, Dhanpuri opencast/underground and Bangwar underground mines are located in Sohagpur area of Shahdol district, Madhya Pradesh (Raja Rao, 1983). The study area lies between the latitude 23° 08' to 23° 12'N & longitude 81° 32' to 81°38'E, covering 84 sq.km area, covering Survey of India toposheet no. 64 E/12. Burhar is the nearest railway station of the study area. The location map is shown in Fig. 1.
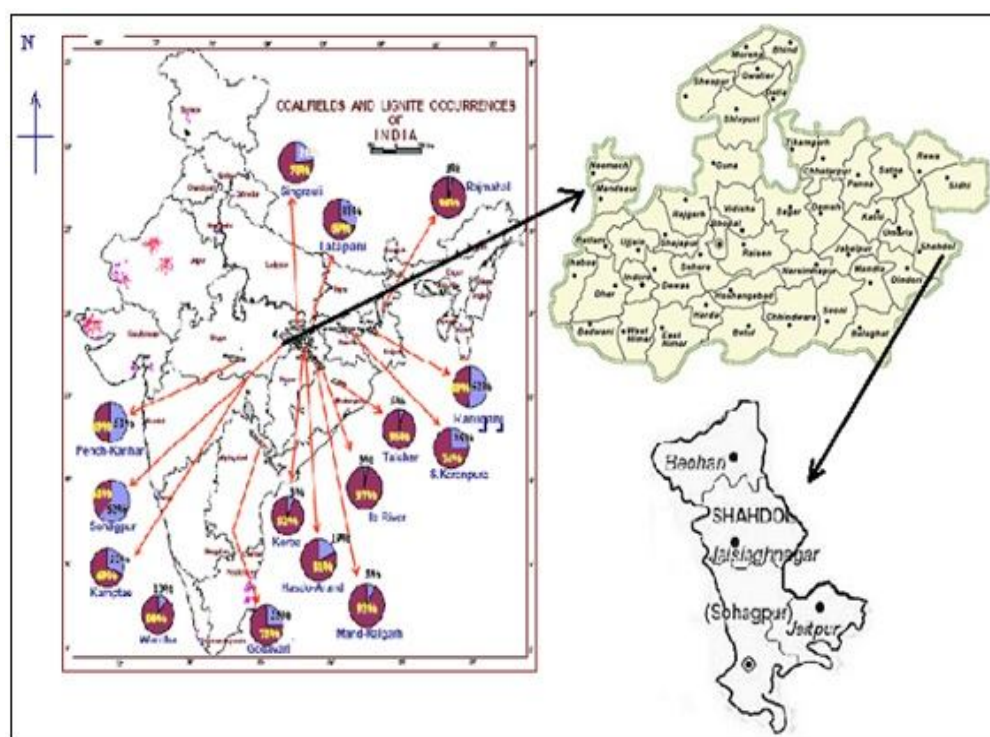

Figure 1: Location Map of the Area, under Study.

Geology of the study area

The Sohagpur Coalfield comprises over 1,000 m thick sedimentary strata. The Barakar Formation is the only coal bearing formation in the coalfield. The coal is being exploited by South Eastern Coalfields Limited (SECL– a subsidiary of Coal India Limited). On the basis of occurrence of coal, the coalfield is divided mainly into three sub basins– Jhagrakhand–Bijuri, Kotma, and Burhar–Amlai. The present study area Amlai opencast/underground, Dhanpuri underground and Bangwar

underground is a part of the Burhar–Amlai subbasin. The age of Barakar Formation is early Permian and the thickness of formation is 450 m. (Coalfield of India, 1983). Barakar Formation is composed of sandstones with bands of shale, carbonaceous shale, and coal seam subdivided into three members lower, middle and upper. The lower member conformably overlies the Talchir Formation and includes a greyish–white feldspathic garnet sandstone, siltstone, and shale, and is devoid of coal seams. The middle member has

the maximum thickness and contains cross–bedded feldspathic sandstones with garnet, and thick workable coal seams in the lower portion. The upper member includes ferruginous sandstones, shales, and siltstones (Jasper *et. al.*, 2016).

Sample collection and analysis

Total nine (09) water samples were collected from Amlai, Dhanpuri and Bangwar mines of Sohagpur area and collected samples were analyzed in Quality Assurance Laboratory for physico-chemical analysis to estimate the quality of mine water in the study area.

Random method has been used for mine water sample collection. The sample has been analyzed by standard methods as per American Public Health Association (APHA, 2005) and compare with Bureau of Indian standard (BIS, 1991). The physico-chemical parameters of water includes pH, Conductivity, Turbidity, Total Dissolved Solids (TDS), Total Alkalinity, Total Hardness, Chloride, Free CO_2, Chlorine, Fluoride, Ammonia, Nitrate, Iron, Sodium, Potassium, Calcium. The water samples were collected from different source as depicted in Table 1.

Table 1: Different location and source of coal mine water samples

Location	Source	Sample ID
Amlai Opencast Mine	Drinking Water	L1
Dhanpuri Underground Mine	Mine Water	L2
Bangwar Underground Mine	Mine Roof Water	L3
Bangwar Underground Mine	Drinking Water	L4
Dhanpuri Opencast Mine	Drinking Water	L6
Amlai Opencast Mine	Sump Water	L7
Amlai Opencast Mine	Mine Water	L8
Dhanpuri Opencast Mine	Mine Water	L9
Dhanpuri Underground Mine	Drinking Water	L11

RESULT AND DISCUSSION

The analytical data and comparison of various physico-chemical parameters with BIS drinking water standard is presented in Table 2 and concentration of hydrochemical parameters are shown in Fig. 2.

As evident from the table, pH value ranges from 7.1 to 7.9 i.e., water samples are neutral to alkaline in nature. All the water samples are within the range as suggested by BIS drinking water standard. Electrical conductivity depends on the temperature and indirectly relates to the salinity (Yadav & Jamal, 2018). Conductivity ranges from 2000 to 13000 µS/cm in the analyzed water samples. All water samples exceed the permissible limit i.e., 2000 µS/cm except from Bangwar Underground Mine (Drinking water). Turbidity is a measure of the cloudiness of water and has been measured by nephlo turbidity meter and it varies from 0.1 to 15.9 NTU and the maximum value is observed in mine water of Amlai Opencast Mine. TDS in water sample ranges from 340 to 1370 mg/l. The highest value is found in Amlai Opencast

Mine (Mine water). Total Alkalinity ranges from 2 to 300 mg/l and the highest value of alkalinity is 300 mg/l in the Dhanpuri Underground Mine Drinking Water and all analyzed samples falls under the permissible limit. Total hardness varies from 16 to 400 mg/l and the maximum value is observed in Drinking Water of Dhanpuri Underground Mine. The minimum and maximum observed value of chloride is 1.0 and 128.7 mg/l respectively and the highest value is found in Mine Water of Dhanpuri Underground Mine. Fluoride ranges from 0.5 to 1.7 mg/l and the highest value found in Mine and Drinking water of Dhanpuri Opencast Mine. Ammonia varies from 0.4 to 0.8 mg/l, nitrate 46 to 54 mg/l, iron 0.3 to 0.5mg/l, sodium 15.3 to 88.2 mg/l, potassium 6.9 to 46.9 mg/l and calcium 29.5 to 42.9 mg/l respectively are within the permissible limit.

After analysing coal mine water, we came to the conclusion that the water running across the mines are mostly affected by mining activities.

Table 2: Analytical data for the coal mines water sample from the study area:

Physico- Chemical parameters	Unit	Sample ID									BIS (10500, 1991) Desirable limit	Permissible limit
		L1	L2	L3	L4	L6	L7	L8	L9	L11		
PH		7.6	7.5	7.8	7.9	7.7	7.5	7.5	7.1	7.3	6.5-8.5	No Relaxation
Conductivity	µS/cm	3000	8000	5000	2000	3000	4000	13000	4000	5000	500	2000
Turbidity	NTU	1.3	0.1	2.0	0.1	0.3	0.2	15.9	14.8	8.0	1	5
TDS	mg/l	420	860	590	340	380	550	1370	550	550	500	2000
Total Alkalinity	mg/l	36	20	48	38	32	12	2	8	300	200	600
Total hardness	mg/l	44	80	70	30	16	38	136	74	400	200	600
Chloride	mg/l	38.6	128.7	29.7	19.8	44.6	19.8	122.8	29.7	1.0	250	1000
Fluoride	mg/l	1.0	1.2	0.5	0.5	1.7	1.6	1.5	1.7	0.5	1.0	1.5
Ammonia	mg/l	0.5	0.5	0.4	0.6	0.8	0.5	0.5	0.5	0.6	0.5	No Relaxation
Nitrate	mg/l	46	49	46	50	49	54	51	48	50	45	No Relaxation
Iron	mg/l	-	0.3	-	0.3	-	-	0.3	0.5	0.4	0.3	1.0
Sodium	mg/l	46.3	88.2	66.9	15.3	43.1	32.5	68.3	21.1	70.4	-	-
Potassium	mg/l	6.9	35.4	9.4	22.0	20.8	16.6	46.9	22.2	21.6	-	-
Calcium	mg/l	29.5	33.5	31.9	31.8	31.1	32.0	42.9	33.1	31.1	75	200
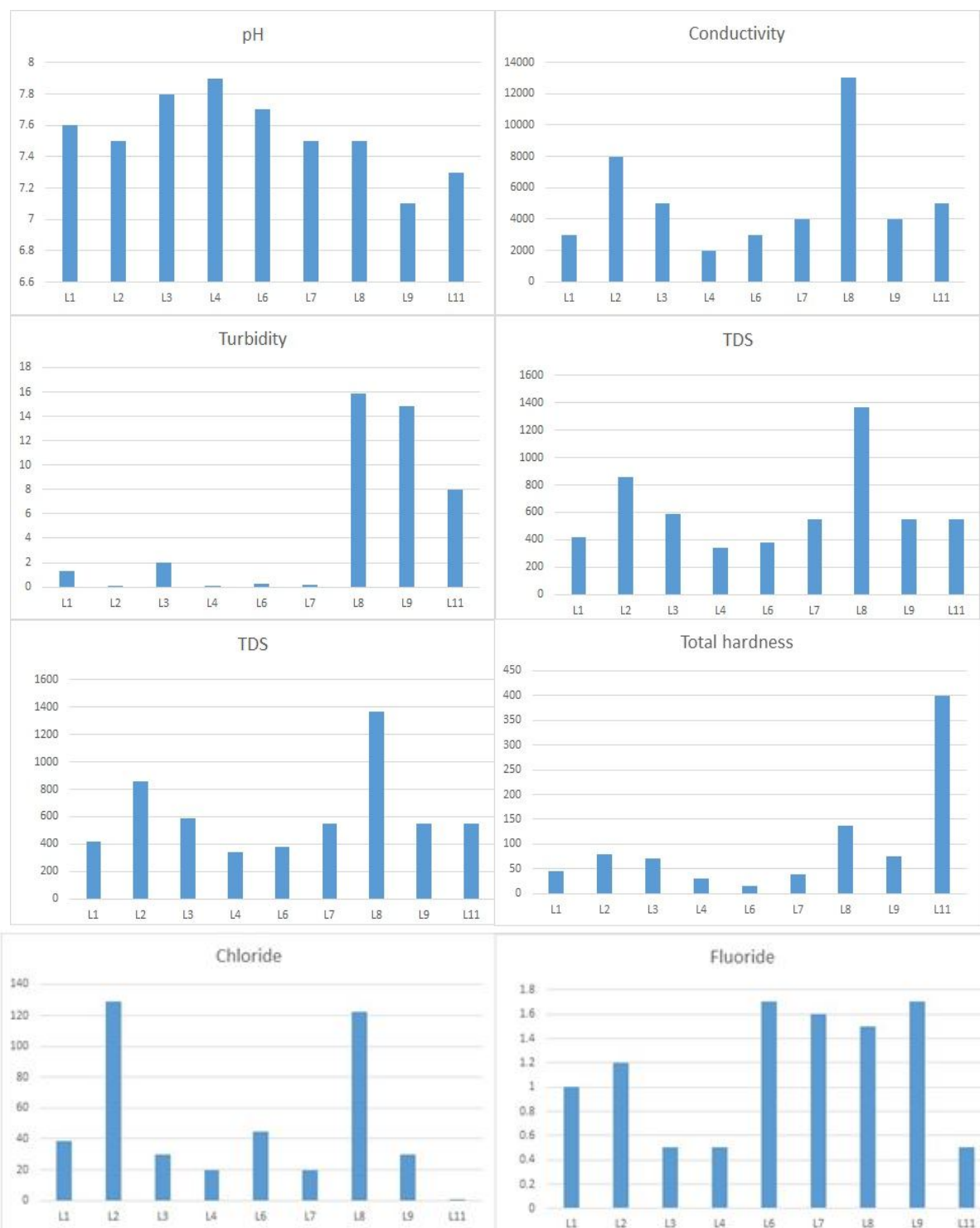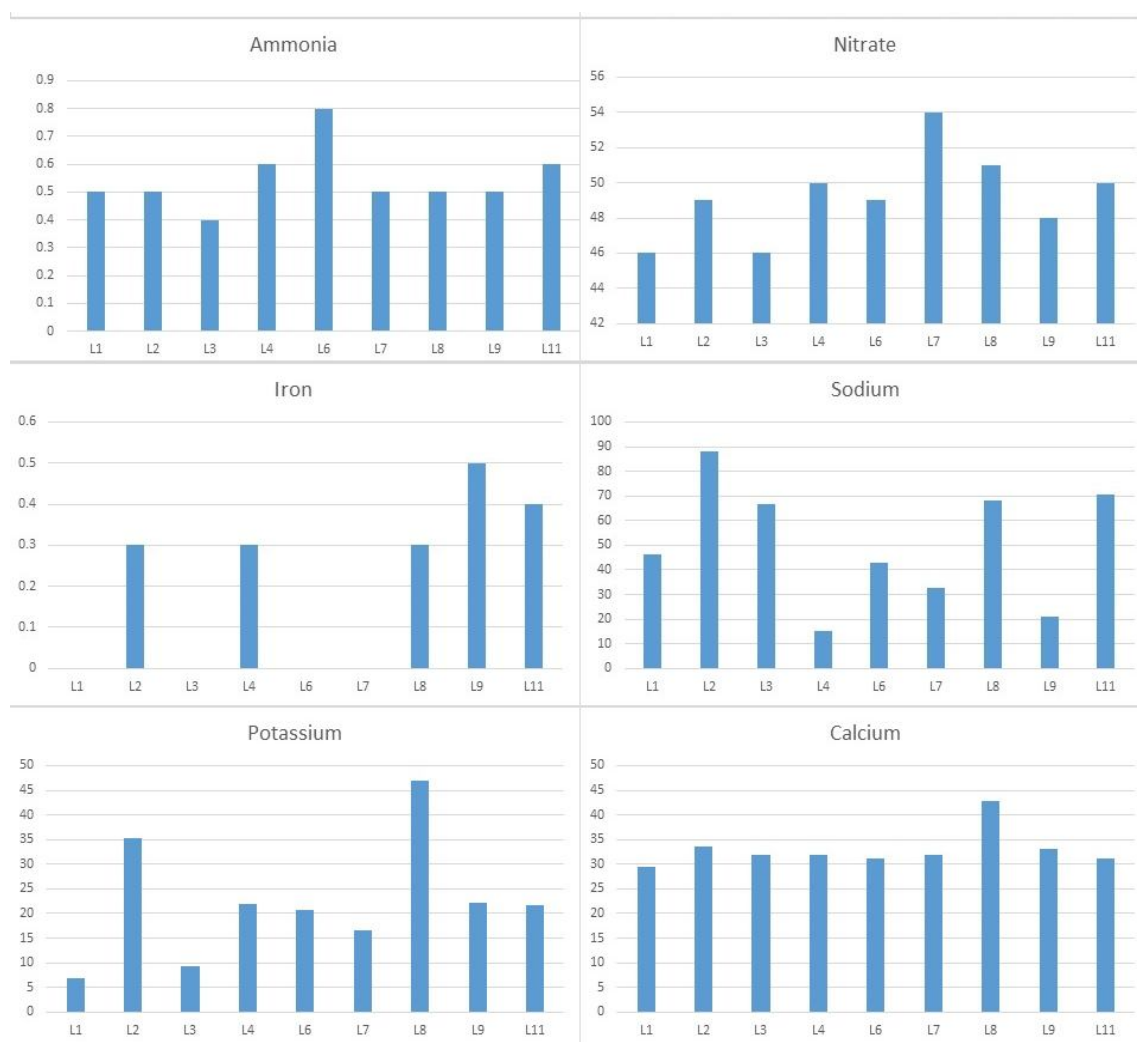
Note: Units of all physico-chemical parameters are measured in mg/l except of pH, turbidity (NTU) and conductivity (µS/cm).

Figure 2: Concentration of analysed physico-chemical parameters of the water sample from different mines of Sohagpur area.

CONCLUSION

Mining activities have a drastic and profound effect on the water quality in the mining area. The ground water which is being polluted by the pollutants released from the mining activities is the objective of this Research paper.

The analytical data shows that conductivity exceeded the permissible limit in all water samples. Conductivity is the result of the presence of mineral salts of elements like sodium, calcium and magnesium. These salts when get dissolved in water, produces free ions that are capable of passing electrical current in water. High conductivity is related to high TDS (total dissolved solids) concentration and amount of dissolved mineral salts in the water. The higher value of Conductivity, turbidity, TH and TDS was found in mine water of Amlai Opencast Mine. Conductivity and turbidity is found in higher amount due to the presence of iron, nitrate, and total dissolved solids. The highest value of fluoride found in drinking and mine water of Dhanpuri Opencast Mine and this water sample also cross the permissible limit. The highest pollution level was found in the mine water of Amlai Opencast Mine (L8) and the

other water sample for Drinking and Mine Water of Dhanpuri Opencast Mine (L6 and L9) can be used after small treatment. Present time all mines in India are working on the concept of zero waste discharge and reuse mine water for different purposes. During Research work some water samples collected from sump and roof of mines and after analysis, authors have come to the conclusion that all samples need to proper effective treatment for domestic use.

Acknowledgement

REFERENCES

1. IEA (2012). International energy agency, 9 rue de la Fédération, 75739 Paris Cedex 15, France
2. Raja Rao C.S. (1983). Coal fields of India, vol-III, Bul GSI, Sr-A No. 45.
3. APHA, (2005). Standard method for Examination of water and wastewater, 21st ed. American public Health Association: Washington, D.C.
4. BIS (1991). Indian Standard: Drinking water – specification, IS: 105000 (Reaffirmed 1993). Bureau of Indian Standard (BIS) New Delhi.
5. Coalfield of India. (1983). Vol. 45(a).
6. H. L. Yadav and A. Jamal (2018). Assessment of water quality in coal mines: a quantitative approach. *Rasayan J. Chem.* 11(1), 46-52.
7. Jasper et al. (2016). Fires in the mire: repeated fire events in Early Permian 'peat forming' vegetation of India. *Geological Journal*, 52, 955–969.

****