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Water Quality Assessment of certain Marble Mining areas of Udaipur District

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ABSTRACT:

The present investigation attempts to assess the impacts of a large scale marble mining operations on the local water quality in certain areas of Udaipur district Rajasthan. Water samples were collected within marble mining and adjacent region. The samples were analyzed for various physico-chemical parameters like pH, alkalinity, TDS, electric conductivity, hardness, nitrate, phosphate. The result of water quality parameters were compared with the standards laid down by BIS and WHO, suitable for drinking and domestic purpose. The results reveal that levels for certain water quality parameters like EC, pH, alkalinity, nitrate, phosphate exceeded the desirable limits prescribed by the BSI and WHO standards. This may be due to the various mining activities in the area. The present investigation is an attempt to determine the physico-chemical parameter of water in the marble mining area.

KEY WORDS: marble, mining, water, total hardness, alkalinity, nitrate, phosphate.

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INTRODUCTION:

Mining is an indispensible component of economic resource in the area under investigation, however most of the operations have an adverse effect on the various environmental factors like the air, water, soil and vegetation. Out of all these factors water is one of the key factors, which has an adverse impact of mining operations. Rural India relies on ground water for drinking and agriculture[1]. Fresh water pollution through heavy use of water in processing ore and mine discharge as mine effluent and seepage from tailings and waste rock impoundments are few of the many problems found in the study area. All types of mining disrupt groundwater flow, which in turn can possibly affect surface waters that are in hydraulic continuity with the affected groundwater systems[2]. Mining activities have often caused releases of contaminants or hazardous constituents to the natural water environment, and its effect may be manifested throughout the mine life cycle[3].

More than 1,500 marble mining units are operating in the Aravallis ranges of Rajasthan, destroying the panoramic beauty of hills apart from disturbing the ecological balance, depleting groundwater and leaving huge dumps of waste and slurry on pasturelands and riverbanks. In the last two decades, the landscape of southern Rajasthan has been completely altered due to continuous anthropogenic activities. Streams and rivers that were the lifeline of the hills for centuries are dried up. The hills stand naked; the lush green canopy which once adorned them is disappearing at very fast pace. Instead a new man made range of marble overburden and slurry is very clearly visible. The Aravallis is now turned into a monotonous white barren range as if it has got a new marble floor that is yet to be polished.

Udaipur district is well known marble mining hub in the national and international scenario. The natural occurrence of marble at study area (Lakhawali, Jaspura Daroli, Oondithal Gogunda) and its commercial exploitation potentially threatens to local ground and surface water resources due to the leachete from the marble containing waste. The objective of this study is to investigate the possibility of adverse effects of marble mining on water quality around the mentioned study area and to characterize the extent and nature of contamination in water as it potentially relates to the marble mine activities.

STUDY AREA:

Rajasthan is the richest state in the country with special reference to marble deposits in both quality and quantity. The state is most important centre (Mandi) of marble processing in the country with about 95% of the total processing units. Rajasthan possesses large reserves of about 1100 million tonnes (M.T) of good quality marble. The important marble deposits in Udaipur district are

Babarmal, Devimata (Pink), Rishabdev, Odwas, Masaron Ki Obri, (Green), Darauli, Tidi, Jaspura, Paduna, Manpur, Lohagarh, Sarvadi, Modi Chipala (White), Kela Kuan (Black).

The Udaipur district is in southern Rajasthan situated between parallels 23˚26', 26˚20' north latitudes and 73˚09',74˚45' east longitude at average altitudes of about 579.4 meter above mean sea level. For the study, three sampling stations (Lakhawali, Jaspura Daroli and Gougunda) of Udaipur district were identified. Area under study is having a large no. of mines where mechanized and semi mechanized mining operations are carried out with advance techniques and machinery.

MATERIAL AND METHODS:

For physico-chemical analysis water samples were taken from open wells, hand pumps, mine pit, tube well, pond during March- April 2014. The samples were collected, transported and analyzed as per standard method given in[4,5,6]. Determination of various physico-chemical parameters like pH, electrical conductivity, total dissolved solids, alkalinity, hardness, nitrates, phosphates has been carried out within 6 hours after bringing the samples from the sampling stations to the laboratory using standard methods.

RESULT AND DISCUSSION:

Table 1 Physico-chemical characterization of ground water

S.NO.	Sample Code	pH	EC	TDS	ALK	TH	NO3-	PO4-
1	L1	8.0	600	376	224	200	4.45	1.01
2	L2	6.6	1765	400	235	230	1.15	0.40
3	L3	6.3	800	998	245	620	3.54	0.50
4	L4	7.6	864	1390	330	550	1.55	0.28
5	L5	7.5	960	409	247	244	1.44	0.45
6	L6	7.0	765	426	221	390	4.08	0.30
7	J1	6.76	1920	1272	384	824	100	0.05
8	J2	7.32	3000	1770	536	908	112	0.05
9	J3	7.34	867	505	336	416	48	0.04
10	J4	6.89	601	340	284	308	08	0.07
11	J5	6.86	768	480	312	360	10	0.05
12	J6	7.01	650	560	410	450	07	0.06
13	G1	7.60	682	387	360	390	06	0.20
14	G2	7.42	558	339	230	260	32	0.40
15	G3	7.05	1130	679	400	340	0	0.60
16	G4	6.92	945	523	320	390	8.5	0.20
17	G5	6.62	1252	770	520	390	18	0.60
18	G6	7.23	1006	559	320	400	20	0.40

The samples were analyzed for the parameters like pH, alkalinity, TDS, electric conductivity, total hardness, nitrate, phosphate. The results of all parameters observed are summarized in this table

All parameters are expressed in mg/L except pH and EC

L-Lakhawali

J-Jaspura

G-Gogunda

Table 2 Comparison of drinking water quality data with WHO standards (1997)

	Lakhawali			Jaspura Daroli			Gogunda			WHO(1997)	
Parameter	Min.	Max.	Mean±SD	Min.	Max.	Mean±SD	Min.	Max.	Mean±SD	Desirable limit	Permissible limit
pH	6.3	8	7.17±0.65	6.76	7.3	7.03±0.25	6.6	7.4	7.14±0.35	7-8.5	6.5-9.2
EC	600	1765	957.33±412.44	601	3000	1301±964.99	558	1252	928.83±264.41	750	1,500
TDS	376	1390	666.5±427.29	340	1770	821.17±569.14	339	770	542.83±165.31	500	1,500
ALK	221	330	250.33±40.44	284	536	377±90.53	230	520	358.33±97.25	200	600
TH	200	620	372.33±178.69	308	908	544.33±255.21	260	400	361.67±54.19	100	500
NO^{3-}	1.2	4.43	2.7±1.48	7	112	47.5±48.01	0	32	14.08±11.54	-	50
PO^{4-}	0.3	1.01	0.49±0.21	0.04	0.1	0.05±0.01	0.2	0.6	0.4±0.18	-	-

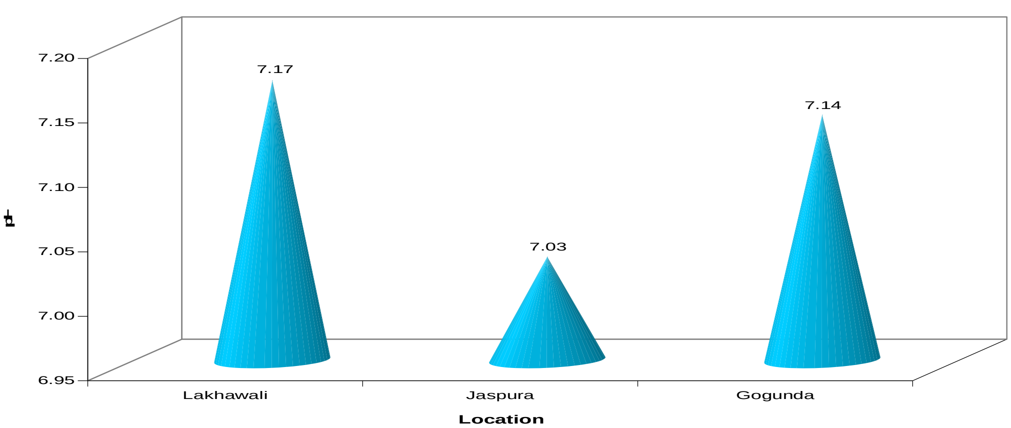

Fig. 1 Graphical representation of pH

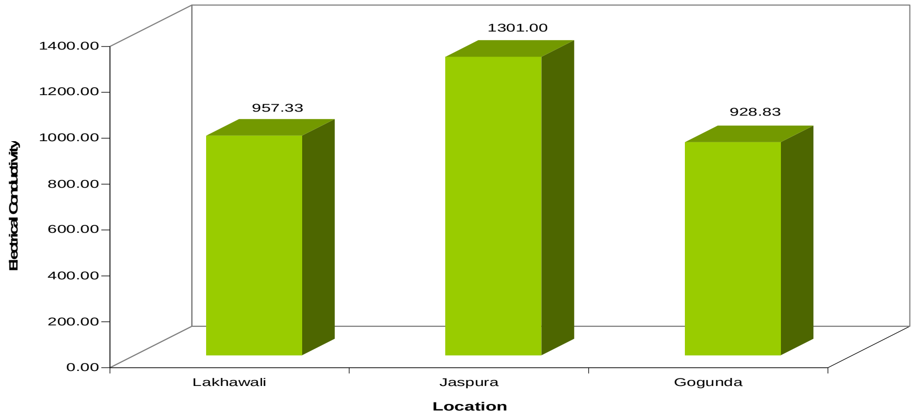

Fig. 2 Graphical representation of electrical conductivity

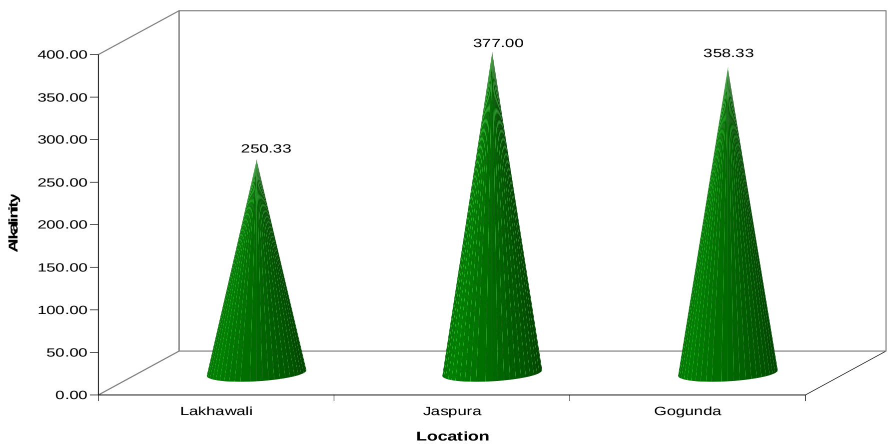

Fig. 3 Graphical representation of total alkalinity

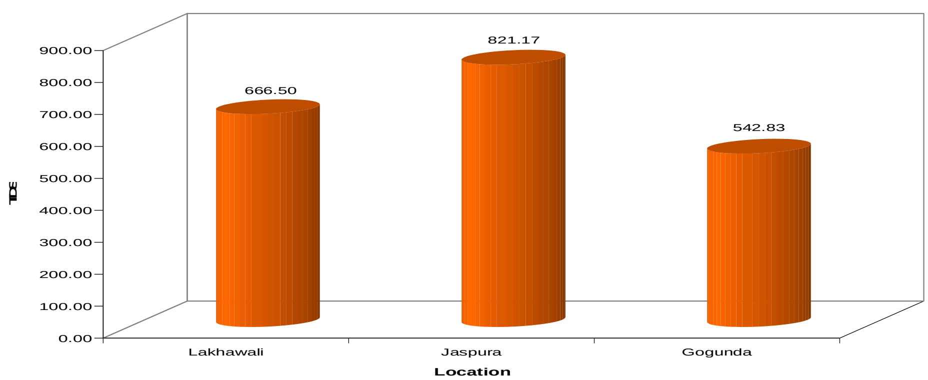

Fig. 1 Graphical representation of TDS

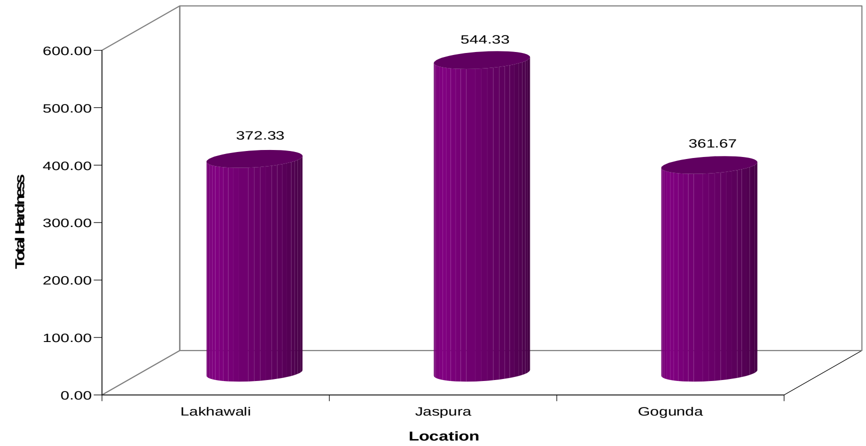

Fig. 2 Graphical representation of Total Hardness

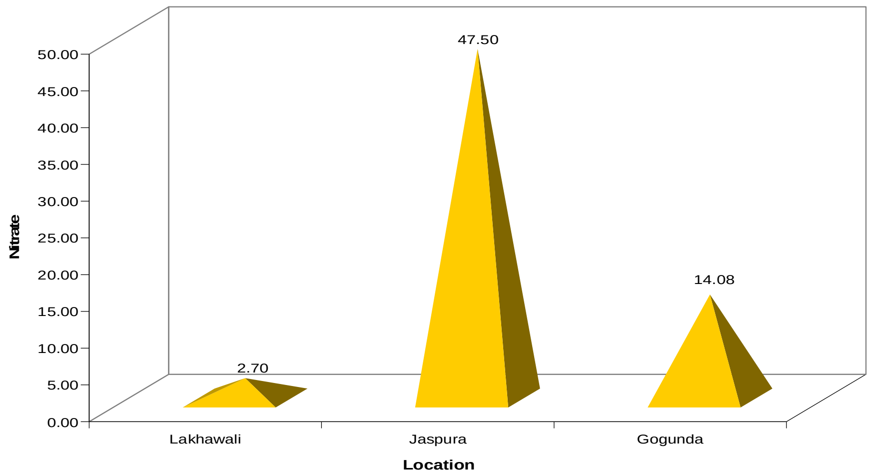

Fig. 3 Graphical representation of nitrate

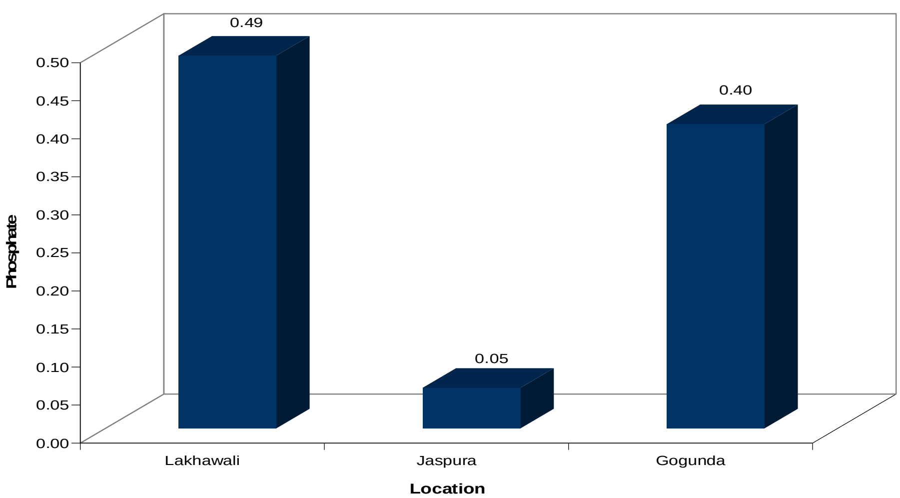

Fig. 4 Graphical representation of phosphate

pH-

In present investigation pH value ranges from 6.3 to 8.0 which is within the permissible limit as shown in table 1. The Lakhawali water had lowest pH of 6.3. [7]reported in their study that low pH was attributable to the leaching of metal values from the dumps, where they are piled in heaps for manual dressing and the generated AMD (Acid Mine Drainage) which is washed into the stream. pH of water samples in study area depicted no remarkable variation as shown in statistical analysis (Figure 1). The samples collected from the core zone exhibited alkaline nature which can be attributed predominantly to the geological formation in this area. The important geological formation in this area is calcite and dolomite in composition which explains the alkaline pH[8]. All pH values of the drinking water of the study area reveal basic nature of water. However, higher values of pH haste the scale formation in water heaters and germical potential of chlorine [9].

Electrical conductivity-

In the present investigation, the conductivity value ranges between 558 to 3000 which is much beyond the desirable limits. The samples collected from marble mining area discerned higher electric conductivity values are attributed to the excessive input of salts and silts[10]. Higher electric conductivity indicates the heavy presence of high amount of dissolved inorganic substances in ionized form. [1]reported in their study that higher concentration of acid, base and salts in the water, will proportionately contributed to the increased EC. The mine water, as compared to the ground water pumped out from wells is characterized by higher contents of almost all dissolved constituents as well as many trace elements.

Alkalinity-

Alkalinity in the analyzed samples ranges between 221 to 536 mg/L (Table1) and statistical data obtained gave highly significant results during this analytical procedure (Figure 3). Most of the samples were found to above the desirable limit. The high alkalinity values in a few samples may be due to the action of carbonates upon the basic materials in the soil and dissociation of marble waste[11, 12] have also studied the ground water quality of marble industrial area of Kishangarh (Ajmer). They have mentioned in their result that the many physico-chemical parameters increase with the addition of marble slurry leading to deterioration of the overall quality of the groundwater. Similar results were obtained by [12] in the water samples where the high alkalinity values of water samples observed from mining region reflect higher carbonate and bicarbonate concentration in water of this area. It is observed in our results that the small scale marble mining and processing units in the study area do not have proper drainage system, which enhances the alkalinity of water beyond the permissible limits as found in the samples which finally results in incrustation of sediments deposits, difficulties in chlorination and other physiological effects on human systems etc. [13]reported that the constituents of alkalinity result from dissolution of minerals substances in the soil and atmosphere contributes to high alkalinity in the ground water.

Total dissolved solids-

In the present study, the values of TDS found between 340 to 1770 mg/L vividly indicating high mineralization in the area. Most of the samples analyzed were found above the maximum permissible limit. It is reported that high TDS content limits the use of ground water for any purpose[14]. Higher value of TDS may attribute to the waste from cutting the slurry generated during the processing of marble blocks, which contaminates the local water systems[15]. Statistical analysis of water samples in study area shows no significant results with average value of 676.83 mg/L. The marble slurry generated during the cutting of marble block is responsible for the higher TDS in mine pit wastes as well. This clearly denotes that the mine water consists of high concentration of minerals and considerable amount of fine marble dust as reported by[15]. High concentration of TDS in ground water may also be attributed to variation in geochemical process and the impact of mining and anthropogenic activities[15]. [2, 16, 17] expressed the dissolution of soil particles containing minerals under slightly alkaline condition, favour the high TDS concentration in groundwater. However TDS concentration above the permissible limit (1500ppm) causes gastrointestinal irritation[18].

Total hardness-

The total hardness values in the study area ranges between 200 to 908mg/L which are much beyond the maximum permissible limits indicating extremely hard water. However in the study area few samples the hardness was found to low making the water soft. The long term consumption of extremely hard water might lead to an increased incident of urolithiosis, anencephaly, parental mortality and certain types of cancer and cardio vascular disorders [5]. In the present study total hardness content in the large no. of samples gave significant results in study area as shown in graph. The higher hardness in study area may be predominantly due leaching of igneous serpentine and carbonate rock. Water containing the soluble salts of calcium and magnesium such as chloride, sulphates and bicarbonates also governs the quality of water [19]. The adverse effects of increased hardness leads to many health problems like kidney stones and the heart diseases [20]. Nevertheless, ground water chemistry is controlled by composition of its recharge components as well as by geological and hydro geological variations [21].

Nitrate-

In the conducted experiments exhibited nitrate value of water sample for Jaspura, Gogunda and Lakhawali, which shows the highly significant results which ranges between 0 to 112 as shown in table 1 and figure 6. The levels of NO_3-N are associated with source availability and regional environmental factors. In regions where well drained soils are dominated by irrigated cropland, there is a strong probability towards the development of large areas with groundwater, which exceeds the maximum contaminant level of 10 mg/L NO_3-N. Excessive use of nitrogenous fertilizers in agriculture has been one of the primary sources of high nitrate in ground water [22,23]. The present research also indicates high concentration of nitrates, which can cause methanemoglobinaemia, gastric cancer, goitre, birth malformations and hypertension as cited by [24]. Nitrates are believed to occur in ground water mainly due to leaching from soil organic matter, leaching of fertilizers applied to soil, while leachets from refuse dumps and industrial discharge also contribute to high concentration of nitrates [10].

Phosphate -

The phosphate content observed well within desirable limits which ranges from 0.04 to 1.01 mg/L. The result of phosphate estimation exhibited a significant value in almost all sampling stations. It has been proposed by scientist’s world over that mineral levels in different bodies of water have profound effect on the levels of phosphates, which ultimately has an adverse impact the overall health of the water and its inhabitants[25]. High concentration may cause vomiting and diarrhea, stimulate secondary hyperthyroidism and bone loss [8].

In the present study, the physico-chemical characteristic of water in marble mining area is fairly suitable for drinking purpose. Although the result of few parameters like nitrate, phosphate, total hardness, alkalinity which determine the quality of drinking water are above desirable limits of BIS and WHO standards, however some other parameters like EC, pH, TDS gave no significant results to adversely affect human health. Finally it is suggested that the concentration of pollutants should be minimized so that the concentration are well below the maximum permissible limit and not much exceeding the desirable limits too in mining areas to protect the health of people in and around the mining area and environment protection is also a primary for sustainable mining . Total pollution or degradation prevention cannot be attained but the important thing is to reduce the effect of pollution and degradation to the nearest minimum.

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