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Hydro Chemical Analysis of Groundwater Quality around Jagdalpur, District Bastar, Chhattisgarh, India

Pooja Gupta[1], Medha Jha[2], D. K. Deolia[3], Sanjay Tignath[4]
[1]*Research Scholar, Department of Geology, Govt. Science College, Jabalpur, India*
[2]*Associate Professor, Department of Civil Engineering, IIT (BHU), Varanasi, India*
[3,4]*Professor, Department of Geology, Govt. Science College, Jabalpur, India*

***Abstract*: Jagdalpur city is located in the southeastern part of the Bastar district in Chhattisgarh, India. The present study is focused on hydro-chemical analysis of ground water quality around the Nagarnar where a steel plant is coming up. Nagarnar village is located between 19.0'0"N to 19.7'30"N and 82.7'30" E to 82.12'30"E longitude. The study area covers an area of 79sq.km. Hydro-climatologically, it falls within the tropical savanna type of climate region. The major source of employment in the area is agriculture industry engaging almost all of workforce. Water sample were collected from 33 stations in the month of January 2017 and were subjected to analysis for chemical characteristics. The January month was chosen as it falls nearly midway between the Pre and Post monsoon seasons. The type of water that predominated in the study area has been found to belong to Ca-MgHco3 type based on hydro-chemical facies.**

***Keywords*: Groundwater Chemical characteristics, piper plot diagram**

1. Introduction

Water quality analysis is one of the most important aspects in groundwater studies. The hydro chemical study reveals quality of water that is suitable for drinking, industrial and agriculture purposes depending upon its quality parameters. Furthermore, it is possible to understand the change in quality if any natural or anthropogenic changes make impacts on the groundwater domain (Kelley, 1940)(Willcox, 1962).

Groundwater manly consists of major cations and anions that are ca+2, mg+2 , cl-1 , HCO3-1 , Na+1, K+1, so42- which form the chemical parameters of the ground water play a specific role in classifying and assessing water quality.

The objective of present work is to discuss the major ions in the chemistry of ground water of Jagdalpur city. In this case the method proposed by Piper Tri-linear Diagram has been used to study the hydro-chemical characteristics of groundwater around Jagdalpur.

2. Study Area

Bastar District is located in the south of Chhattisgarh state & Nagarnar village is located between 19.0'0" N to 19.7'30" N and 82.7'30" E to 82.12'30" E cover an area. According to water atlas of India watershed code 4E2GA1a, 4E2G4A1c, 4E2G4A1d, 4E2G4A1e, 4E2F1D2c, 4E21D2d (SLUSI.in) have taken under study.

The major industries in the study area are that of rice mil, stone crushing and mining. Movement of groundwater is affected by lithology, structure of rock and thickness of the formations. There is Indrāvati River which is the main source of water for drinking, agriculture and other purposes. The river drains from east to west direction and is popularly called the lifeline of Bastar District.

3. Methodology

Ground water sample were collected from 33 locations from Jagdalpur city for Jan 2017, a midpoint between Pre and Post Monsoon seasons so as to assess average quality of water. The water samples were collected from the hand pump, Dug-well in the polythene bottles of 1 liter capacity for detailed chemical analysis. Chemical analysis was carried out for the major ion concentration of the water sample collected from different location using the standard procedure recommended by APHA-1994 (12) and details are shown in Table 4.

The analytical data can be used for the classification of water for multipurpose use and for ascertaining a variety of factors on which the chemical characteristics of water depends.

4. Result and discussion

The maximum and minimum concentrations of major ions present in sample population of the ground water from study area are presented in the Table 1. The Piper tri-linear diagram (Stiff J.H, 1940) is used to infer hydro geochemical facies. These are plotted which are contained in two triangles, one for plotting cations (Table 2) and other plot of anions (Tabel 3). The cations and anions fields are combined to show a single point in a diamond shaped field, from which inference is drawn on the basis of hydro geochemical concept.

These tri-linear diagrams are mostly useful in willing out chemical relationship among groundwater sample. Table 1 Maximum and minimum concentration of Major Ions of

groundwater sample.

Table 1
Maximum and Minimum Ions

Ions	Minimum(in ppm)	Maximum(in ppm)
Na+	0.1	20
K+	0.2	18
Ca+2	0	240
Mg+2	8	144
CO32-	0.1	0.1
HCO32-	15	315
Cl-1	10	80
So4-2	0.5	12

5. Interpretation

Piper's diagram has been extensively used to understand problems about the geochemical progression of ground water. The diagram consists of three distinct fields, two triangular fields and the third a diamond shaped field. In the two triangular fields, the values are plotted separately in the percentage epm concentration. The groups of anions and cations are plotted in two triangular diagrams, in one triangular field, the group of cations, namely Ca and Mg (Alkaline earth) and Na+K (alkali), and the other group of anions namely HCO3 (weak acid) SO4 and Cl (strong acid) in the other triangle. The overall characteristics of the water is represented in the diamond-shaped field by projecting the position of the plots from the triangular fields figure (1.1) Minor alkalies like potassium and strong acids like iodide, fluoride and nitrate, are clubbed with major ones(Karanth, 1987).

Different types of ground water can be divided by the position and lumping of the projected plotting from the triangular fields. The type of water is deciphered from the sub-field which most of the projected values occupy in the diamond-shaped field. In given figure 1.1 of the Piper Tri-linear diagram that the ground water of the study area belongs the CaMgHCO3 facies, indicating that the calcium and magnesium are measure cations in the groundwater of the study area and comprise about 65 to 75% of the cations.

Bicarbonate is measure anion in the groundwater of the study area. It comprises about 60 to 70 % of the anion as the plot of the chemical quality data in the present study shows that the groundwater has dominance of calcium bicarbonate.

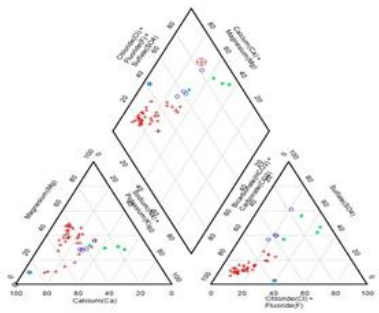

Fig. 1. Ground water sample plotted in piper tri-linear diagram

The Ca-Mg and HCO3 indicate the temporary hardness alkalinity and the total hydrochemistry is dominated by alkaline rock that is calcareous shale in the present study area.

Table 2
Cations chemistry

Calcium(Ca)	Magnesium(Mg)	Sodium(Na) + Potassium(K)	
Bottom	Left	DIAMOND	
Ca	Mg	Na + K	Total
1.85	1.07	0.43	3.35
1.18	1.33	0.40	2.91
1.63	1.81	1.00	4.44
1.45	1.40	0.75	3.60
2.45	1.65	1.58	5.67
1.55	1.40	0.77	3.72
1.37	1.16	0.35	2.87
2.35	1.81	1.23	5.39
2.25	1.81	1.31	5.36
1.72	1.15	0.31	3.18
2.17	1.74	0.67	4.59
1.79	2.07	1.94	5.80
1.63	1.72	0.85	4.21
1.94	2.54	1.05	5.53
1.50	1.03	0.43	2.96
1.80	1.65	0.50	3.94
1.85	0.97	1.13	3.94
1.74	0.24	0.37	2.35
1.86	0.28	0.57	2.71
1.55	1.73	0.41	3.69
1.50	1.73	0.45	3.67
1.50	1.73	0.35	3.57
1.50	1.81	0.36	3.67
1.33	1.30	0.35	2.98
1.75	1.32	0.41	3.47
1.60	1.56	0.40	3.56
1.45	1.56	0.29	3.30
1.55	1.73	0.40	3.67
2.28	0.55	0.91	3.74
1.80	0.60	1.00	3.40
3.69	0.45	0.69	4.83
1.84	0.86	0.45	3.14
1.30	1.03	0.41	2.74
1.29	1.08	0.42	2.79
1.80	1.54	1.70	5.04
1.80	1.56	1.57	4.93
5.99	6.42	9.24	21.65
7.49	13.16	25.71	46.36
5.49	9.05	14.88	29.42
2.62	2.30	2.30	7.23
0.70	0.08	0.03	0.81
3.14	3.54	3.22	9.90
3.69	2.37	2.50	8.56
3.35	2.41	2.62	8.37
3.87	2.47	2.33	8.67

Table 3
Anion chemistry

Mill equivalents			
Chloride(Cl) + Fluoride(F)	Sulfate(SO4)	Bicarbonate(HCO3) + Carbonate(CO3)	
Bottom	Right	DIAMOND	
Cl + F	SO4	HCO3 + CO3	Total
0.57	0.40	2.30	3.27
0.35	0.26	2.18	2.79
0.72	0.52	2.28	3.52
0.54	0.38	2.50	3.42
1.11	1.45	2.82	5.38
0.59	0.46	2.54	3.58
0.32	0.27	2.22	2.81
1.38	0.96	2.74	5.07
1.28	0.97	2.76	5.01
0.22	0.34	2.49	3.05
0.42	0.64	2.98	4.04
1.81	1.37	2.82	6.00
0.83	0.65	2.72	4.19
0.63	0.69	3.20	4.52
0.28	0.27	2.30	2.85
0.81	0.60	2.44	3.86
0.52	0.58	2.75	3.85
0.09	0.15	0.89	1.14
0.43	0.50	1.86	2.79
0.50	0.41	2.56	3.47
0.51	0.41	2.58	3.50
0.38	0.34	2.62	3.34
0.42	0.37	2.68	3.47
0.38	0.26	2.31	2.95
0.55	0.44	2.20	3.19
0.30	0.42	2.58	3.30
0.33	0.26	3.02	3.61
0.53	0.39	2.60	3.52
0.65	0.38	2.11	3.14
0.62	0.37	2.40	3.39
0.26	0.33	2.04	2.64
0.29	0.31	2.32	2.92
0.36	0.30	2.18	2.84
0.29	0.28	2.14	2.71
1.26	1.22	2.56	5.03
1.20	1.17	2.48	4.84
6.28	11.66	2.96	20.90
21.03	21.24	2.96	45.23
13.47	12.16	3.10	28.73
2.05	2.63	2.48	7.16
0.57	0.05	0.84	1.46
2.16	6.25	1.84	10.25
1.82	3.33	3.18	8.33
1.87	3.33	3.23	8.43
1.67	3.33	4.11	9.12

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Table 4
Chemical analysis data

Sample no.	Source	Lat.	Long.	VILLAGE	Calcium	Magnesium	Total hardness	Sodium	Phosphorous(ppm)	Total-iron(mppm)	Manganese(mppm)	Total suspended solid(mppm)	Total dissolved solid(mppm)	pH	Conductivity (µS/cm)at 23C	Turbidity(NTU)
1	HANDPUMP	19°04'56.6"	82°12'41.4"	DHANPUNJI	0	16	16	BDL	0.04	0.06	0.04	250	43.67	6.4	88.13	383
2	HANDPUMP	19°05'07.0"	82°10'57.6"	KASTURI	4	20	24	BDL	0.04	0.06	2.2	100	19.24	5.7	38.25	12.4
3	HANDPUMP	19°05'15.3"	82°09'21.1"	MAGANPUR	8	24	32		0.04	0.01	BDL	BDL	7.628	5.4	14.55	BDL
4	DUGWELL	19°05'17.5"	82°09'30.4"	MAGANPUR	8	32	40	0.1	0.05	0.06	BDL	BDL	30.35	5.6	60.92	BDL
5	DUGWELL	19°06'17.5"	82°09'40.3"	URANRAL	12	8	20	0.9	0.04	0.02	0.02	BDL	32.88	5.6	66.08	BDL
6	HANDPUMP	19°06'29.4"	82°09'19.9"	BIJAPUT	16	20	36	BDL	0.05	3	0.11	150	57.45	6.4	116.2	280
7	HANDPUMP	19°06'07.9"	82°08'15.1"	MANJHIGUDA	16	8	24	BDL	0.06	0.02	0.07	300	36.07	5.9	72.6	40.6
8	DUGWELL	19°05'27.5"	82°08'28.1"	MADPAL	24	76	100	4.3	0.04	BDL	BDL	BDL	66.24	5.6	134.2	BDL
9	DUGWELL	19°06'57.4"	82°09'08.9"	KARANPUR	32	20	52	BDL	0.09	0.04	0.16	50	37.3	6.5	75.09	2.4
10	DUGWELL	19°05'42.0"	82°11'02.4"	CHOKAWADA	32	16	48		0.04	0.04	0.12	BDL	44.49	7	89.78	BDL
11	DUGWELL	19°04'25.9"	82°08'25.1"	JARIGUDAPARA	36	64	100	3.9	0.11	0.06	0.08	BDL	88.05	6.7	178.7	1.6
12	HANDPUMP	19°07'28.7"	82°08'37.9"	BHALUGUDA	40	40	80	BDL	0.05	0.06	0.17	100	40.34	6.2	81.31	311
13	HANDPUMP	19°04'28.4"	82°08'18.7"	JARIGUDAPARA	44	24	68	0.3	0.05	BDL	0.01	50	76.54	6.4	155.2	3
14	DUGWELL	19°06'00.1"	82°10'46.2"	NAGARVAR	44	36	80	8.7	0.05	0.02	0.02	BDL	139	5	282.6	BDL
15	HANDPUMP	19°05'40"	82°06'17.0"	MORATHPAL	48	68	116	BDL	0.04	0.04	0.35	150	85.74	6.5	174	63
16	DUGWELL	19°04'10.0"	82°08'39.3"	MARVEL	52	12	64	0.2	0	0.06	BDL	BDL	62.07	6.6	125.6	BDL
17	DUGWELL	19°06'04.7"	82°08'43.0"	MANJHIGUDA	56	28	84	5.3	0.06	0.08	BDL	BDL	130.7	6.9	265.6	BDL
18	DUGWELL	19°06'28.2"	82°09'15.3"	BIJAPUT	56	41	97	BDL	0.04	0.04	BDL	BDL	75.87	6.3	153.8	BDL
19	HANDPUMP	19°06'57.5"	82°12'13.2"	BHEJAPADAR	64	48	112	5.6	0.04	0.08	0.02	50	125	6.7	254.1	8
20	DUGWELL	19°05'00.2"	82°09'19.6"	MAGANPUR	88	32	120	20.2	0.07	0.02	BDL	BDL	296.4	7	601.8	BDL
21	DUGWELL	19°04'53.3"	82°09'25.4"	MANGANPUR	92	140	232	BDL	0.1	0.02	0.02	BDL	180.3	7.9	367	BDL
22	DUGWELL	19°05'42.0"	82°11'02.4"	KASTURI	96	100	196	11.6	0.1	0.04	BDL	BDL	305.5	6.9	622.5	BDL
23	DUGWELL	19°03'41.1"	82°07'57.6"	SIVANAGUDA	100	72	172	BDL	0.06	0.04	BDL	BDL	208.4	7.4	424.4	BDL
24	HANDPUMP	19°06'48.6"	82°09'09.5"	KARANPUR	108	136	244	BDL	0.07	0.02	BDL	BDL	196.3	6.8	397.3	BDL
25	HANDPUMP	19°03'39.2"	82°07'04.1"	KOPAGUDA	116	76	192	BDL	0.04	BDL	BDL	BDL	204.7	6.5	416.8	BDL
26	HANDPUMP	19°03'53.4"	82°07'17.2"	KHUTPADAR	120	144	264	BDL	0.03	BDL	0.08	100	273.7	7.3	557.5	8
27	HANDPUMP	19°04'09.7"	82°07'22.2"	KHUTPADAR	136	100	236	BDL	0.03	0.08	BDL	BDL	229.3	7.3	462.3	BDL
28	DUGWELL	19°05'00.2"	82°12'50.1"	DHANPUNJI	144	44	188	9.2	0.06	0.18	0.01	50	240.8	6.5	490.3	2
29	HANDPUMP	19°04'36.3"	82°11'05.1"	CHOWKAWADA	156	40	196	BDL	0.06	0.04	0.1	BDL	151.7	7.8	308.5	BDL
30	HANDPUMP	19°06'22.3"	82°09'52.2"	URANRAL	160	120	280	BDL	0.07	0.08	0.12	BDL	214.7	7.5	437.1	BDL
31	HANDPUMP	19°06'06.5"	82°10'43.5"	NAGARNAR	172	92	264	BDL	0.06	0.06	0.2	BDL	198.5	7.4	404.2	BDL
32	HANDPUMP	19°05'05.0"	82°06'27.1"	KHAVARGAON	192	8	200	BDL	0.05	0.18	0.01	BDL	228.8	7.5	466	BDL
33	HANDPUMP	19°05'28.1"	82°08'16.1"	MADPAL	240	20	260	BDL	0.05	0.02	BDL	BDL	259.9	7	529.3	BDL

6. Conclusion

Type of water that predominates in the Nagarnar Village, Jagdalpur city Chhattisgarh area is Ca-MgHCO3 type as found for the groundwater samples of 2017 based on hydro-chemical facies. This study may be useful as a reference in the future impact assessment studies.

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