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HYDROGEOCHEMICAL INVESTIGATION AND GROUNDWATER QUALITY ASSESSMENT OF RAJAMPETA AREA, CUDDAPAH DISTRICT, INDIA.

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Abstract:

Hydrogeochemical characteristics and quality of groundwater in around Byrapur chromite mining area have been evaluated based on different indices for assessing groundwater for drinking purposes. Thirteen groundwater samples were collected and analyzed for physiochemical parameters and major ions. The results revealed that the groundwater is alkaline in nature. Most of the groundwater from the study area is suitable for drinking purposes and very few samples are unsuitable for drinking and domestic purposes. Concentrations of bicorbanate, chloride, and magnesium in one water sample each are beyond the safe limits of drinking water indicating contamination. Concentrations of TDS, EC in all samples are desirable limit. The analytical data of the groundwater in the study area indicates that nitrate in three groundwater samples exceeded the desire limit and is not suitable for drinking purpose. Overall the analytical data of the groundwater indicates that groundwater is suitable for drinking purpose with few exceptions.

Keywords: Groundwater quality, Hydrogeochemistry, Rajempeta, Andhra Pradesh

Introduction

Groundwater is the major source of water for domestic, drinking, agricultural and industrial purposes in India. Water causes more than 80% of the diseases affecting mankind. The quality of groundwater within a region is governed by both natural process and soil erosion and anthropogenic effects such as industrial and agricultural activities. The quality of groundwater has major impact on human health. Slight change in water quality reflects improper functioning of water ecosystem (Thakkar and Gwalani, 1987). The chemical composition of groundwater is controlled by many actors, including the composition of precipitation, geologic structure and mineralogy of the watersheds (Elango and Ramachandran1991). Poor quality of water adversely affects the plant growth and human health (Wilcox, 1984; Todd, 1980; Hem, 1991). The quality of groundwater varies from place to place, with the depth of water table, and from season to season. The quality is primarily governed by the extent and composition of dissolved solids present in water. Assessment of groundwater quality requires determination of ion concentration which decides the suitability for drinking uses. Various workers has contributed their work in different areas especially related to the quality with reference to drinking and irrigation (Thakkar and Gwalani, 1987).In the present work,

hydrochemical studies and quality of groundwater in and around Lingala area of Kadapa District, Andhra Pradesh are carried out in order to evaluate its suitability for drinking purpose.

Study Area :

The investigation area, Rajampeta (Lat. 14^0. 20 N; Long 79^0 15' E) is located in Cuddapah District, Andhra Pradesh, India. The geological formations in this mineralized belt are shales, and quartzites. In this area the chief soil types are black cotton, red soils, alluvial, brown and mixed soils. Agriculture is the major occupation of the people of the area. The climate of the area is characterized by hot summers and mild winters. Maximum temperature is 36ºC is during summer. During winter minimum temperature is 22ºC. Groundwater occurs in the study area under semi-confined conditions. The fractures constitute the porosity and permeability of the rocks. The study area receives the rainfall mostly from September to December. Rainfall is the chief source of groundwater recharge and this water is the source for drinking and irrigation purpose. The important crops of this area are paddy, cotton, groundnut, and chilies.

Sampling and Analytical procedure

Thirteen groundwater samples were collected in one liter pre-washed polyethylene bottles from bore wells of the study area in the year 1998. Chemical analysis of water samples were carried out following the standard analytical methods (APHA, 1992) for various parameters like calcium (Ca^{++}), magnesium (Mg^{++}), sodium (Na^{+}), potassium (K^{+}), bicarbonate (HCO_3^{-}), and carbonate (CO_3). The physical parameters include pH, electrical conductivity (EC) and total dissolved solids (TDS) were measured immediately in the field. Results of chemical analysis of groundwater samples are represented in Table 1.

Results and Discussions

Analytical results of the groundwater samples (Table 1) are compared with the standard limits recommended by Bureau of Indian Standards (1991) guidelines values for drinking water (Table 2).

Hydrochemical Characterization

The pH of the water samples ranges from 7.3-8.6 (Avg 7.88) indicating alkaline nature of the water. The safe limit of the pH is between 6.5 and 8.5 as per BIS (1991). This indicates that almost all the groundwater samples lie within the safe limit. As per BIS (1991) except one sample all the remaining samples are within recommended limits (6.5 to 8.5) for human consumption. EC values varied from 418 to 973 (Avg 696.33) uS/cm. The permissible limit of EC of groundwater should be 2000 uS/cm. The EC in 100% groundwater samples remains within the safe limit. Concentration of dissolved solids is an important parameter for drinking water. The desirable limit of TDS in groundwater is 500 mg/l, while the maximum permissible limit is 2000 mg/l as per BIS (1991).The total dissolved solids (TDS) concentration varies between 227 to 670 (Avg 433.13) mg/l. All thirteen samples are within safe limits as per BIS (1991). Groundwater may be classified based on TDS following Wilcox (Wilcox,1955). The suitability of groundwater is judged on the basis of TDS concentration. If TDS concentrations is upto 1500 mg/l water is permissible for domestic use, 1500-3000 mg/l water is useful for irrigation and if it is >3000 mg/l water

is Unsuitable for domestic agriculture and industry (Table 3).In the study area 100% samples are permissible for domestic use.

Table 1: Geochemical analysis results of groundwater in the study area [ionic concentration in mg/l except pH and EC (*u*S/cm)]

S.No	pH	EC	TDS	Ca	Mg	Na	K	Cl	HCO_3	NO_3	CO_3
1	7.9	746	469	69	10	38	2	178	185	62	45
2	7.5	968	560	195	20	47	5	15	369	34	40
3	8.6	751	484	56	23	20	2	31	165	18	10
4	8.4	765	475	68	33	19	2	67	125	27	50
5	7.3	438	227	94	29	51	3	22	185	17	35
6	7.9	503	315	85	20	25	4	68	338	60	28
7	8.1	418	258	95	24	21	6	73	610	50	13
8	7.3	530	353	28	17	20	4	68	176	16	56
9	7.6	549	336	69	15	40	3	52	165	26	14
10	8.0	973	670	72	26	47	5	18	123	42	22
11	7.6	965	572	55	21	15	2	30	257	18	12
12	8.2	856	498	64	29	27	12	46	146	23	31
13	7.9	592	383	66	30	13	2.5	280	188	17	18
Min	7.3	418	227	28	10	13	2	15	123	16	10
Max	8.6	973	670	195	33	51	12	280	610	62	56
Avg	7.88	696.33	433.13	82.6	22.66	29.8	4.43	82.86	251	32.53	29.33

Table 2 Range in values of chemical parameters in groundwater of the study area and Indian Standards (IS: 10500) BIS (1991) for drinking water. [The values are in mg/l except pH and EC (*u*S/cm)

Parameter	BIS (1991) IS: 10500		Concentration range mg/l (values within brackets are average)	No. of samples beyond HDL	No. of samples beyond MPL
	Highest Desirable (HDL)	Maximum Permissible (MPL)			
PH	6.5-8.5	No relaxation	7.3-8.6 (7.88)	12	1
EC	--	--	418 to 973 (696.33)		
TDS	500	2000	227 to 670 (433.13)	13	-
Na	--	--	13 to 51(29.8)		
Ca	75	200	28 to 195 (82.6)	09	4
Mg	30	100	10 to 33 (22.66)	12	1
K	--	--	2 to 12 (4.43)		
HCO_3	200	600	123 to 610 (251)	12	1
CO_3	--	--	10 to 56 (29.33)		
Cl	250	1000	15 to 280 (82.86)	12	1
NO_3	45		16 to 62 (32.53)	10	3

Table 3. Classification of Groundwater Based on TDS

TDS in mg/l	Suitability	% of Samples in the study area
Up to 1500	permissible for domestic use	100%
1500- 3000	Useful for irrigation	
>3000	Unsuitable for domestic agriculture & industry	

Anionic Chemistry

The concentration of bicarbonate (HCO_3) varies in the range of 123 to 610 (Avg 251) mg/l. The analytical data show that HCO_3 exceeds the safe limits of 600 mg/l in only one groundwater sample rest of the samples are within permissible limits. The concentration of carbonate (CO_3) varies in the range of 10 to 56 (Avg 29.33) mg/l. Chloride in groundwater may originate from both natural and anthropogenic sources. However, abnormal concentration of chloride may result from anthropogenic sources including agricultural runoff, domestic wastes and leaching of saline residues in the soil (Appelo, and Postma,1993). The desirable limit of chloride is 250 mg/l and permissible limit of chloride is 1000 mg/l as per BIS (1991). Chloride concentration ranges from 15 to 280 (Avg 82.86) mg/l. Chloride concentrations exceed the desirable limit in one sample. High concentration of chloride in groundwater samples may be attributed to the local recharge domestic wastes.

Nitrate concentration ranges from 16 to 62 (Avg 32.53) mg/l. Nitrate concentrations exceed the desirable limit in three samples and is unsuitable for drinking purpose. This may be attributed to anthropogenic pollutant contributed by excess use of nitrogenous fertilizers. The highest concentration of nitrate in drinking water is toxic and causes blue baby disease/methaemoglobinaemia in children and gastric carcinomas (Comly, 1945;Gilly et al 1984). Many incidences of nitrate pollution in groundwater water have been reported by several workers (Uma, 1993; Pawar and. Shaik, 1955).

Cationic Chemistry:

The permissible limit in drinking water for Na is 200 mg/l as per WHO (1984).The concentration of sodium is reported in the range of 13 to 51(Avg 29.8) mg/l. Sodium ion concentration in all groundwater samples are within permissible limit as per WHO (1984).Ca and Mg are essential nutrients for plants and animals, and also essential for bone, nervous system and cell development. Ca and Mg in drinking water may provide nutritional benefits for the people. The concentration of calcium (Ca) in the groundwater was reported to be in the range of 28 to 195 (Avg 82.6) mg/l. The desirable limit of calcium in drinking water is 75 mg/l and the maximum permissible limit is 200 mg/l as per BIS (1991). The concentration of calcium exceeds the desirable limit of 75 mg/l in four water samples; however all the samples are within permissible limit. The concentration of potassium (K) ranges from 2 to 12 (Avg 4.43) mg/l. Magnesium (Mg) contents ranges from 10 to 33 (Avg 22.66) mg/l. The desirable limit of magnesium in drinking

water is 30 mg/l and the maximum permissible limit is 100 mg/l as per BIS (1991). Magnesium ion concentration exceeds the desirable limit in one groundwater sample.

Conclusions

To determine the suitability of groundwater for drinking purposes, hydrochemical parameters of the study area are compared with guideline recommended by BIS, 1991.Groundwater in the investigated area is alkaline category. The results revealed that most of the groundwater from the study area is suitable for drinking purposes and very few samples are unsuitable. Most of the groundwater from the study area is suitable for drinking purposes and very few samples are unsuitable for drinking and domestic purposes. Concentrations of bicorbanate, chloride, and magnesium in one water sample each are beyond the safe limits of drinking water indicating contamination. Concentrations of TDS, EC in all samples are desirable limit. The analytical data of the groundwater in the study area indicates that nitrate in three groundwater samples exceeded the desire limit and is not suitable for drinking purpose. This may be attributed to anthropogenic pollutant contributed by excess use of nitrogenous fertilizers. Overall the analytical data of the groundwater indicates that groundwater is suitable for drinking purpose with few exceptions.

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