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Original Research Paper

Groundwater Quality Assessment of Miyapur Area in Ranga Reddy District, Andhra Pradesh, India

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ABSTRACT

A detailed study on hydrochemistry of groundwater in Miyapur area, Ranga Reddy District, Andhra Pradesh, India has been carried out to assess the quality of groundwater for determining its suitability for drinking purpose. The area, underlained by grey and pink granites of granitoid complex, is associated with profused injections of aplite and fine grained quartzo felspathic veins and pegmatites basic intrusives, which include dolerite, gabbro and pyroxenite, cut across rocks in the study area. Red sandy soils and laterite soils are major soil types in this area. Twenty groundwater samples have been collected from bore wells during premonsoon and postmonsoon seasons of the year 2008. The samples were analysed for various water quality parameters such as pH, electrical conductivity, total dissolved solids (TDS), major cations like calcium, magnesium, sodium, potassium, and anions like chloride, nitrate, fluoride and sulphate. The physicochemical parameters have been compared with the standard guideline values as recommended by WHO and BIS for drinking and public health. It is observed that the pH value is not exceeding the excessive limits in both premonsoon and postmonsoon. Overall, the samples of premonsoon and postmonsoon seasons are not exceeding the excessive limits of calcium. All the samples of both premonsoon and postmonsoon are exceeding the excessive limits of magnesium, which indicates that the water is becoming hard due to the pollutants coming out from the industries. Sodium and potassium indicates increase in levels of sodium in groundwater due to percolation from sodium and potassium bearing minerals. Anions like chloride in all the samples are not exceeding the permissible limits. The concentration of nitrate is above permissible limits. The concentration of fluoride is below permissible limits in postmonsoon. Sulphate concentration is less than permissible limit in all the samples of premonsoon and postmonsoon.

INTRODUCTION

Water can be used as a multiple resource for all the living beings on the earth. The assessment of groundwater quantity and quality is very much important for the maximum use of water resources. In the present scenario, even though there is abundant quantity of water is available, it is rare to get good quality of water. Hence, people use borewell water for drinking and in industries. So, borewell water is selected for physicochemical analysis in the present studies. The study area was comprised in and around Miyapur area, Ranga Reddy, Andhra Pradesh. Twenty borewell water samples were collected. The study has been conducted with an objective of evaluating hydrogeochemical characteristics of groundwater in the study area, and compare the groundwater quality parameters with the World Health Organisation (WHO 1983) and Bureau of Indian Standards (BIS 1998) standards prescribed for domestic and industrial purposes.

STUDY AREA

The Miyapur area is located in Ranga Reddy district in Andhra Pradesh and falls under the catchment of Pamla vagu stream which meets Nakkavagu, a tributary of Manjira river. It is situated about 30 km to the north-west of Hyderabad city. It is located around 78°15’79” to 78°21’36” E longitudes and 17°29’29” to17°32’367” N latitude. It is found in the SOI Toposheet No. 56K/7NW.

The study area is hard-rock terrain comprising of grey and pink granites of granitoid complex, and associated with profused injections of aplite and fine grained quartzo felspathic veins and pegmatites basic intrusives, which include dolerite, gabbro and pyroxenite cut across all the rocks in the study area. Red sandy soils and laterite soils are major soil types in this area. The average annual rainfall is 800 mm. The area receives 578mm south west monsoon and 132 mm in north east.

MATERIALS AND METHODS

Sampling techniques: Samples of borewell water were collected in high grade plastic bottles of one litre capacity rinsed with distilled water, and before collection of samples they were rinsed thrice with the sample water.

Analytical techniques: Samples were brought to the laboratory and the parameters like pH, electrical conductivity and total dissolved solids (TDS) were measured immediately. Other physicochemical parameters were analysed within 36 hours. Standard methods were adopted for the analysis of water samples (APHA, AWWA, WPCF 1989).

RESULTS AND DISCUSSION

The results of the study along with the standards are given in Table 1 and Table 2. On the basis of various physicochemical parameters each water sample was classified into within permissible limits (WPL), below permissible limits (BPL) and above permissible limits (APL) as prescribed by WHO (1983).

pH: The pH affects the taste of water. The pH value of natural waters changes due to biological activity, temperature and disposal of industrial wastes as well as due to acid mine drainage. In this study, it was observed that the pH value in 14 samples is above permissible limits (APL) and in 5 samples in below permissible limits (BPL). Overall, the pH of the samples is not exceeding the excessive limits in both premonsoon and postmonsoon seasons.

Electrical conductivity (EC): Electrical conductivity depends upon TDS present in water. The concentration of dissolved salts increases the conductivity, which also depends on temperature of water. If the temperature increases by 1°C, conductivity increases by 2 %. Electrical conductivity of waters in the study area varies from 680 to 3200 μS/cm in both pre and postmonsoon seasons with slight variations.

Total dissolved solids (TDS): The total dissolved solids (TDS) of groundwater indicate all ionized and nonionized materials in dissolved form. In the study area, the TDS values vary from 258 to 725 mg/L in premonsoon and 240 to 725 mg/L during postmonsoon. The concentration of TDS was below permissible limits (BPL) in 3 samples, above permissible limits (APL) in 9 samples and above excessive limits in all 8 samples of premonsoon and postmonsoon.

Calcium: The calcium forms the principal cation in most of the natural freshwater samples, as it is an essential constituent in the igneous rocks. The extreme mobile nature in hydrosphere is responsible for the occurrence of calcium as one of the major constituents in groundwaters. The presence of other cations like potassium and sodium also influences the concentration of calcium. The calcium concentration in the groundwater ranges from 24.58 to 301.6 mg/L during premonsoon, and from 2.1 to 151 mg/L during postmonsoon season. There are 5 samples of premonsoon exceeding the permissible limits and 2 out of 20 samples are exceeding the permissible limits in postmonsoon. In general, the samples of premonsoon and postmonsoon seasons do not exceed the excessive limits.

Magnesium: Magnesium is an important cation of groundwaters in the study area. The source of magnesium in groundwaters is due to the ionic exchange of minerals in rocks and soils by water. Magnesium and calcium together are major contributors to hardness of waters. In the present study magnesium varies from 181 to 648.1 mg/L during premonsoon and 85 to 296.5 mg/L during postmonsoon. All the samples of both premonsoon and postmonsoon exceed the excessive limits of magnesium which indicates that the water is becoming hard due to pollutants.

Sodium: Sodium is the predominant chemical constituent of waters. The primary source of sodium in natural waters is mostly due to release of soluble products during the weathering of basic plagioclase feldspars. Another reason for the presence of sodium is the use and reuse of water in irrigated areas. Apart from total concentration, the nature of various cations and ratio of sodium ion to the total cations are important factors in determining SAR and % of sodium, which show the distribution of sodium in the study area. In the present study sodium varies from 80 to 624 mg/L during premonsoon, and from 1.6 to 10.4 mg/L during postmonsoon. Increase in levels of sodium in groundwater is due to the percolation of sodium bearing minerals.

Potassium: Potassium is another alkaline metal and minor chemical constituent in groundwater of the investigated area. It is an essential nutrient for both plant and animal life. Concentration of potassium in the area during premonsoon ranges from 25 to 75 mg/L, and during postmonsoon from 10.3 to 39.3 mg/L. Potassium for all the 20 samples indicates increase in its levels due to percolation of water through potassium bearing minerals.

Chloride: Chloride occurs in natural water with widely varying concentration. Chlorides gain access to natural water through many ways particularly because of solvent power of water, which dissolves chloride from topsoil as well as from deeper formations. The increase of chloride concentration in certain waters is due to the lateral movement from the source. The higher concentration of chloride above 250 mg/L makes the water salty in taste. The concentration of chloride in the study area during premonsoon varies from 63.2 to 1460mg/L, and in postmonsoon from 18 to 168.2 mg/L. Chloride in all the samples except for 8 samples does not exceed the permissible limits. In postmonsoon season the samples are within the permissible limits because of the dilution of water.

Nitrate: In natural surface waters, nitrate content is low. Very small amount of nitrogen is present in rocks but it is concentrated to a greater extent in soils or biological material. Nitrogen compounds applied to soils decompose to ammonia and nitrate ions. Nitrate itself may be carcinogenic without formation of nitrosamines (Breimer 1982).

Unaffected natural water sources contain only low levels of nitrates (Boerlin 1986). Nitrate occurrence in groundwater is very common. It is mainly due to aerobic decomposition of nitrogen from organic matter, which is leached out from soil to groundwater. Nitrate from other sources like fertilizers, industrial effluents and septic tanks also contributes to groundwater. Generally, nitrate concentration in groundwater range from few milligrams to several hundred mg/L. The concentration of nitrate in the study area varies from 28 to 710mg/L during premonsoon and from 16 to 290.1

mg/L during postmonsoon. The concentration of nitrate is above permissible limits (> 45mg/L) in 15 samples in premonsoon, and in 9 samples above permissible limits in postmonsoon, which shows the growth of industries in the surrounding areas.

Fluoride: The guideline value of fluoride is 1.5 mg/L in drinking water. Fluoride is more commonly found in groundwater than the surface water through weathering of primary silicates and associated accessory minerals (Thakare et al. 2005). The excessive amount of fluoride causes fluorosis having disfigurement of teeth known as mottled enamel and deformities in bones (Kulshreshtha et al. 2004). However, presence of less than 0.8 mg/L fluoride in water causes dental carries in children.

The concentration of fluoride in the study area ranges between 0.5 and 2.6 mg/L during premonsoon, and from 0.02 to 0.5 mg/L during postmonsoon. The fluoride concentration is slightly increasing but not beyond the permissible limit. The concentration of fluoride is below permissible limits (BPL) in 6 samples, above permissible limits (APL) in 3 samples, and above excessive limits in 11 samples of premonsoon. All the samples of postmonsoon are below permissible limit (BPL) of the fluoride concentration.

Sulphate: The sources of sulphate in rocks are sulphur minerals and sulphate of metals that occur in igneous and metamorphic rocks. Apart from natural sources, sulphates are introduced through the application of sulphatic soil conditions. Sulphates do not affect the taste of water. The concentration of

Table 1: The physicochemical parameters of 20 water samples during premonsoon-2008 of the study area with drinking water standards of WHO and BIS.

Sample Id	pH	EC	TDS	Ca	Mg	Na	K	Cl	NO_3	F	SO_4
1	8.5	1500	300	301.6	283.3	98	25	195	60	1.3	30
2	7.4	1200	350	72.24	271.8	97	43	98.3	67	1.7	29
3	8.1	1300	452	24.63	224	100	32	165	58	1.3	35
4	6.9	1400	240	81.57	234.3	105	45	99.32	710	1.6	26
5	8.2	1100	560	29.73	244.5	120	50	196	160	1.8	36
6	6.7	1000	600	109.1	472.5	90	45	163	34	1.0	19
7	7.3	900	650	70.47	245.7	150	48	100	36	1.5	40
8	5.9	800	258	16.12	280.3	100	55	165	265	0.96	20
9	7	1200	300	12.39	468.4	105	41	190	262	1.9	24
10	7.1	1300	280	14.71	648.1	80	43	648	50	0.53	38
11	7.2	1100	480	16.34	592.4	120	32	441	210	1.9	28
12	6.2	900	460	83.31	403.8	130	50	186	360	2.6	39
13	6.9	1100	500	72.3	308.9	140	44	213	52	2.6	33
14	6.3	1400	725	20.51	484.6	115	48	370	190	0.55	50
15	7.1	1426	700	37.65	288.3	251	32	365	49	0.5	55
16	5.6	1523	725	12.54	476.2	265	41	523	61	1.6	49
17	7.1	680	620	25.07	181	144	49	63.2	33	0.28	55
18	5.6	720	520	108.9	349.7	98	42	325	110	0.39	35
19	7.1	1500	584	43.94	189.5	624	65	1460	28	1.37	115
20	6.6	320	458	24.58	200.8	364	72	693	200	3.5	96
BIS (1998) P	6.5	-	500	75	30	-	-	250	45	1.0	200
BIS (1998) E	9.2	-	1000	200	100	-	-	1000	45	1.5	400
WHO (1993) P	6.5	-	300	75	50	-	-	200	-	-	200
WHO (1993) E	8.5	-	600	200	150	-	-	600	45	-	400

Where, P-Permissible limit, E-Excessive limit. All parameters are expressed in mg/L except pH and electrical conductivity (μmhos/cm).

Table 2: The physicochemical parameters of 20 water samples during postmonsoon-2008 of the study area with drinking water standards of WHO and BIS.

Sample Id	pH	EC	TDS	Ca	Mg	Na	K	Cl	NO_3	F	SO_4
1	8.5	1500	300	151	132	1.6	10.3	90	22.1	0.7	18.8
2	7.4	1200	350	32.1	8501	2.8	25.1	18	24.5	0.09	24.1
3	8.1	1300	452	12.1	96.3	4.3	16.9	76.5	16.4	0.05	34.3
4	6.9	1400	240	40.1	115.3	4.5	24.6	36	290.1	0.5	16.1
5	8.2	1100	560	17.1	122.4	3.2	25.3	56.3	68.8	0.09	18.5
6	6.7	1000	600	59.2	234.7	8.5	14.4	28.3	18	0.04	80.1
7	7.3	900	650	30.4	120.4	10.4	25.4	28.6	16	0.08	24.2
8	5.9	800	258	81.3	136.2	5.2	26.4	56.8	163	0.04	10.1
9	7	1200	300	6.2	185.3	6.1	23.3	88.3	165	0.09	12.5
10	7.1	1300	280	3.5	132.6	3.1	24.3	168.2	25	0.04	23.7
11	7.2	1100	480	81.3	296.5	6.2	19.3	106.3	108	0.005	14.6
12	6.2	900	460	62.4	192	6.6	24.5	70.5	170	0.04	18.8
13	6.9	1100	500	42.1	151.3	9.3	20.3	82.5	28	0.08	13.5
14	6.3	1400	725	31.0	237.4	6.3	22.3	165.4	89	0.04	20.4
15	7.1	1426	700	10.4	123.6	2.2	20.3	108.2	36	0.03	16.3
16	5.6	1523	725	15.2	218.3	4.5	24.5	135.5	35	0.09	24.4
17	7.1	680	620	42.2	85.6	9.2	25.4	28.4	16	0.03	25.4
18	6.6	720	570	21.3	168.2	8.8	14.5	84.6	59	0.02	14.2
19	6.7	1500	584	11.3	94.5	4.3	30.5	43.5	20	0.08	50.6
20	6.9	3200	458	2.1	96.2	9.1	39.3	26.5	109	0.02	40.2
BIS (1998) P	6.5	-	500	75	30	-	-	250	45	1	200
BIS (1998) E	9.2	-	1000	200	100	-	-	1000	45	1.5	400
WHO (1993) P	6.5	-	300	75	50	-	-	200	-	-	200
WHO (1993) E	8.5	-	600	200	150	-	-	600	45	-	400

Where, P-Permissible limit, E-Excessive limit. All parameters are expressed in mg/L except pH and electrical conductivity (µmhos/cm).

sulphate in premonsoon varies from 19 to 115 mg/L, and during postmonsoon from 10.1 to 80.1mg/L. Sulphate concentration is less than permissible limits in all the samples of premonsoon and postmonsoon.

CONCLUSION

Interpretation of hydrochemical data reveals that groundwater in Miyapur area is slightly hard, fresh to brackish and slightly alkaline in nature. Nitrate concentration is high (> 45mg/L) in most of the groundwater samples which may cause the blue baby syndrome in infants. Fluoride concentration is also high (> 1.5 mg/L) in most of the samples which may lead to dental and skeletal fluorosis. In general, the groundwater samples have the values, which are above the permissible limits but below the excessive limits. This indicates that there is a chance for these parameters to go further higher in concentration after some years due to the industries in surrounding areas. Hence, it is suggested that the water for drinking is pretreated before consumption.

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