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PRELIMINARY INVESTIGATIONS OF GROUND WATER QUALITY IN HYDERABAD CITY, ANDHRA PRADESH, INDIA

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ABSTRACT

A study of hydrochemical processes in the capital of Andhra Pradesh was carried out with an objective of identifying the geochemical processes and their relationship with ground water quality as well as to get an insight into hydrochemical evaluation of ground water. Various graphical plots and other parameters of groundwater were compared with different water standards and other conventional methods of data analysis were also used to evaluate the quality of ground water for utilitarian purposes based on the ionic constituents, water type and hydrochemical facies.

Key words : Groundwater, Hydrochemical, Water quality, Hyderabad.

INTRODUCTION

In many parts of India, especially in the semi arid tracts, due to vagaries of monsoon and scarcity of surface water, dependence on ground water resource has increased tremendously in recent years. Viewed in the International perspective of '<1700m^3/person/year' as water stressed and '< 1000m^3/person/year' as water scare, India is water stressed today and is likely to be water scare by 2050[1].

Hyderabad being a rapidly growing city in Asia, is facing both; groundwater quality and quantity problems due to its ever increasing construction activity along with rapid industrial and population growth including floating population needs huge quantity of clean and safe water to cater to domestic and other requirements. The recent development of Hyderabad city as an IT destination and the establishment of many reputed National and International Companies and Institutions have put tremendous pressure on the

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requirement of quality water. The city is forced to meet substantial quantity of its water requirement from ground water especially during summer. Expect some reports on flurosis; no document information is available on the extent of population that is exposed to contaminated ground water in different parts of Hyderabad. Earlier studies indicated that unlined drains and pollution dumping sites and let out of untreated industrial effluents in the recharge areas acts as source of pollution.

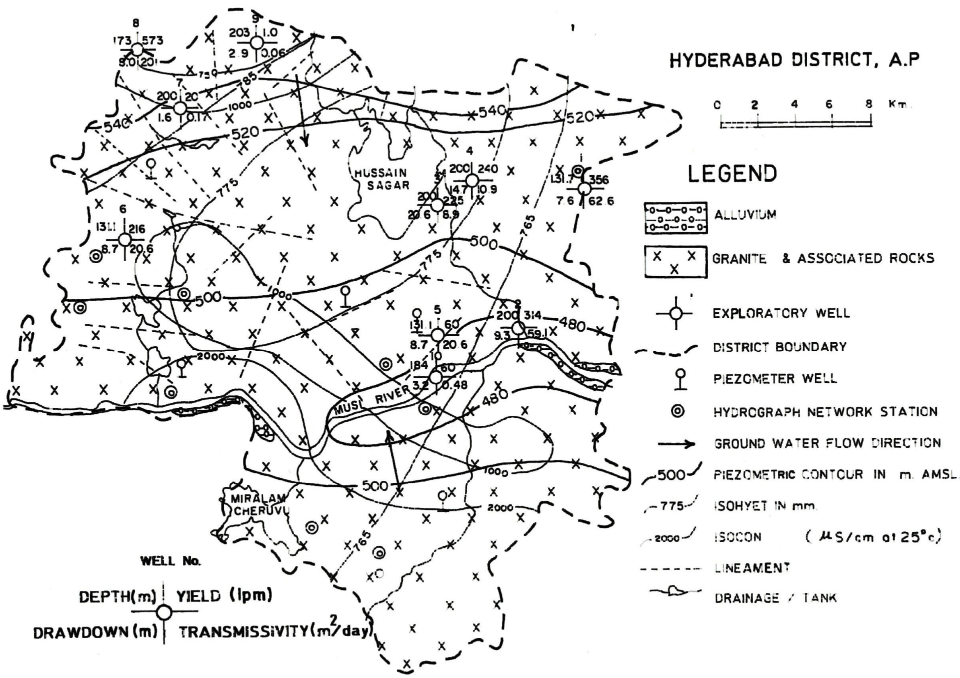

Fig. 1: Hydrogeology

Study area

The state capital of Andhra Pradesh, Hyderabad lies between North latitude 17° 19' 30" and East longitude 78° 23'- 78° 30'. The Hyderabad region is a part of stable Deccan Plateau in semi arid region of Telangana with a gentle undulating topography marked by hills and knolls, at an elevation ranging from 487-600 m above mean sea level. Lithologically the area is underlain by the Archean crystalline complex comprising the peninsular gneissic complex and consists mostly of medium to coarse grained, pink and grey coloured gneissic granites. The granites are exposed in the form of sheets and domes. Numerous dolerite dykes, pegmatite bands and quartz reefs traverse the host rocks in N-S, E-W and NW-SE directions. The fracture density is high in the eastern, western and northern parts while it is moderate to low in central part of the city (CGWB, Reports).

The climate is of semi-arid nature due to marked diurnal differences of temperature, high saturation and moderate rainfall. The climate is marked periodic and is characteristic by a dry and gradually increasing hot season between March and June, a dry and cold winter from November to February and monsoon period from July to October. The normal annual rainfall is 772 mm of which 72% is the contribution from the SW monsoon, 14% from the NE monsoon and the rest during winter and summer. The ground water of the area occurs under phreatic conditions in the weathered portion and semi-confined state in the fractured zones of the rocks.

EXPERIMENTAL

Methodology

Initially to understand the general variation in ground water chemistry over the study area, a well inventory survey was carried out with the support of topographic sheets of Survey of India. The data was used to select the representative wells for ground water sampling. Sampling wells were selected in such a way that they represent varying geological formations, land use pattern and topography of the area. Ten ground water samples were collected from different parts of the area (Fig. 1) following the procedure given by Rain water and Thatcher[2] and Brown[3]. The samples were chemically analysed for various parameters following standard methods of APHA[4].

The geochemical properties of ground water depend on the rock-water interaction and the chemistry of the water in the recharge area as well as the different geochemical processes that are occurring in the subsurface. These geochemical processes are responsible for the spatial variations in the groundwater chemistry[5]. Ground water chemically evolves by interacting with aquifer minerals or internal mixing among different groundwater along - flow paths in the subsurface[6-8]. Further, the weathering of primary and secondary minerals also contributes to the aquifer system[9-10].

RESULTS AND DISCUSSION

In the present study, a detailed investigation was carried out with an objective of identifying the groundwater quality, prominent water quality parameters controlling the hydrochemical evolution of aquifer system was studied. The major ion chemistry of the area showing various statistical parameters are given in the Table 1

Table 1.Summary of statistical data of chemical composition of groundwater (mg/L)

Constituents	Minimum	Maximum	Mean	Standard deviation
pH	7.05	7.92	7.54	0.308
EC (μS/cm)	850	2930	1573	741
TH	250	801	442	161
Ca^{2+}	44	224	110	52.1710
Mg^{2+}	12	86	42	21.34
Na^{+}	46	449	164	117.5918
K^{+}	1.20	12	4.69	3.4050
CO_3^{2-}	0	0	0	0
HCO_3^{-}	214	671	398	140.42
Cl^{-}	78	390	186	105.9824
SO_4^{2-}	29	202	98	66.5306
NO_3^{-}	1	248	99	75.452
F^{-}	0.50	2.57	1.35	0.0601
SAR	1.07	9.06	3.38	2.24841
TDS	483	1674	893	426.9711
RSC	-6.97	1.72	-2.25	2.59989

The data obtained by chemical analyses were evaluated in terms of its suitability for drinking and general domestic use. A comparison of ground water quality of the area has been made with WHO International standards[11] and BIS[12] and is presented in Table 2.

Table 2. Comparison of the quality parameters of groundwater samples of the study area with WHO and ISI standards for drinking purpose (mg/L)

Water quality parameter	WHO max accept limit	WHO max allow limit	BIS max accept limit	BIS max allow limit	Concen-tration in study area
pH	7.0	8.5	6.5	8.5	7.05-7.92
EC (μS/cm)	400	2000	500	2000	850-2930
TH	100	500	300	600	250-801
Ca^{2+}	75	200	75	200	44-224
Mg^{2+}	50	150	30	100	12-86
Na^{2+}	-	200	-	200	46-449
K^{+}	10	12	-	-	1.20-12.00
CO_3^{2-}	-	-	-	-	0-0
HCO_3^{-}	-	-	-	-	214-671
Cl^{-}	200	600	250	1000	78-390
SO_4^{2-}	200	400	150	400	29-202
NO_3^{-}	45	-	45	100	1-248
F^{-}	0.6	1.5	0.6	1.5	0.50-2.57
TDS	500	1500	500	1500	483-1674

The pH value of the area ranges between 7.05 – 7.92 indicating low alkalinity of water. Electrical conductivity is found to be in the range of 850 μS/cm to 2930 μS/cm. Electrical conductivity (EC) is very important parameter in determining the water quality because it is an indicator of salinity of ground water, which controls the taste of drinking water. Taste is an important factor in acceptance of water by user for drinking purpose. The major chemical constituents which contribute to the electrical conductance are components of hardness (Ca^{2+} and Mg^{2+}). Other components which also contribute to the electrical conductance are nitrate, chloride and sulphates. The concentration of Total Dissolved Solids (TDS) of the study area varies between 483 to 1674 mg/L. It is also evident from the classification of water type on the basis of their TDS values ref. Catroll[13], Freeze and Cherry[14], Fetter[15] and Davis and Dewiest[16], which are presented in Table 3.

Table 3. Classification of water by salinity after Davis and Dewiest[16]

Name	Concentration of TDS (mg/L)	% of samples
Fresh	0 – 1000	70
Brackish	1001 – 10000	30
Salty	10001 – 100000	-
Brine	>100000	-

Hardness is an important criterion for determining the usability of ground water. Classification of ground water of this area based on hardness after Sawyer et al.[17] is presented in Table 4.

Table 4. Classification of water by hardness after Sawyer et al.[17]

Hardness (mg/L)	Water class	Sample numbers
0 – 75	Soft	Nil
75 – 150	Moderately hard	Nil
150 – 300	Hard	6, 7.
Over 300	Very hard	1, 2, 3, 4, 5, 8, 9, 10.

Hardness is caused by divalent metallic ions dissolved in water, principally calcium and magnesium. The most important anions with which they are associated are HCO_3^-, SO_4^{2-}, Cl^-, NO_3^-, etc. Anomalies in hardness in ground water have no proven health hazards, but their adverse effect causes more consumption of detergents at the time of cleansing.

The chloride concentration of the area varies between 78 and 390 mg/L which, indicates that all the samples are in acceptable limit except one sample, which is in maximum permissible limit. The nitrate (NO_3^-) content in the groundwater sample of the area varies from 1-248 mg/L except for three samples; in all other samples, the concentration of nitrates are above permissible limits, indicating large scale anthropogenic activity and leachates from landfill sites and domestic sewage.

The high concentration of nitrate in the study area is due to the dumping of solid wastes into the vacant lands. The nitrifying bacteria in presence of dissolved oxygen generate nitrate leading to high nitrate content in groundwater at some places. Apart from the above said source, the contribution from the decaying organic matter and sewage wastes is enormous and the wells located in highly populated areas show high concentration of nitrate.

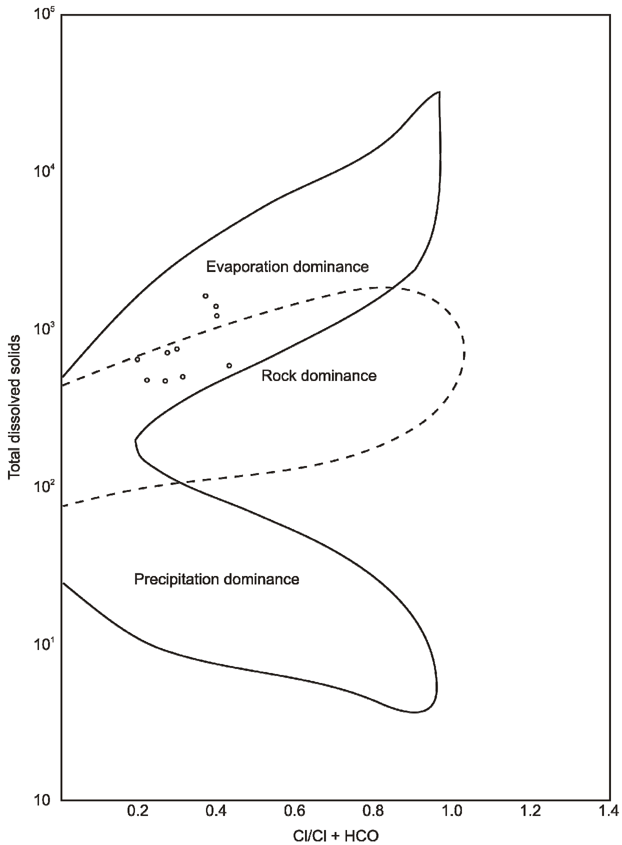

Fig. 2: Gibbs variation diagram (Ratio –I)

The sulphate content of the groundwater from the area under investigation is well within the permissible limit whereas bicarbonate is the predominant ion in the area, except one sample; all other samples are within the maximum desirable limit.

The recommended limit of fluoride concentration in drinking water is 0.6 to 1.5 mg/L BIS, (1991)[12] and ICMR, (I975)[18] based on average of the maximum daily temperature. So, potable water should have the above said limit of fluoride for substantial protection against dental cavities and tooth decay[19,20].

The concentration of fluoride in the area varies between 0.50 to 2.57 mg/L, the higher concentration of fluoride is found in BJR Nagar, Rehmath Nagar, Borabanda and just above maximum permissible level (MPL) is found in New Bhoiguda.

Some of the mechanisms that control chemical composition of the major dissolved salts of the waters of the earth have been discussed by Conway[21], Gorhan[22] and Garrels and Christ[23]. However, further investigation have been observed by Gibbs[24] because many aspects of the over all mechanisms are still poorly understood. He suggested a graphical diagram to understand the water chemistry relationship of the chemical components of the water from the respective aquifers, such as chemistry of the rock types, chemistry of the precipitated water and rate of evaporation.

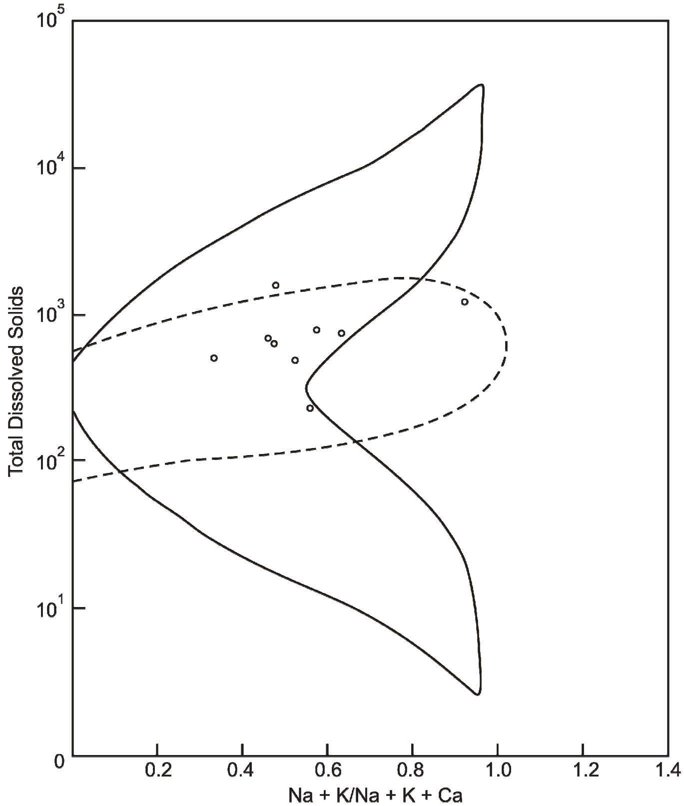

Fig. 3: Gibbs variation diagram (Ratio –II)

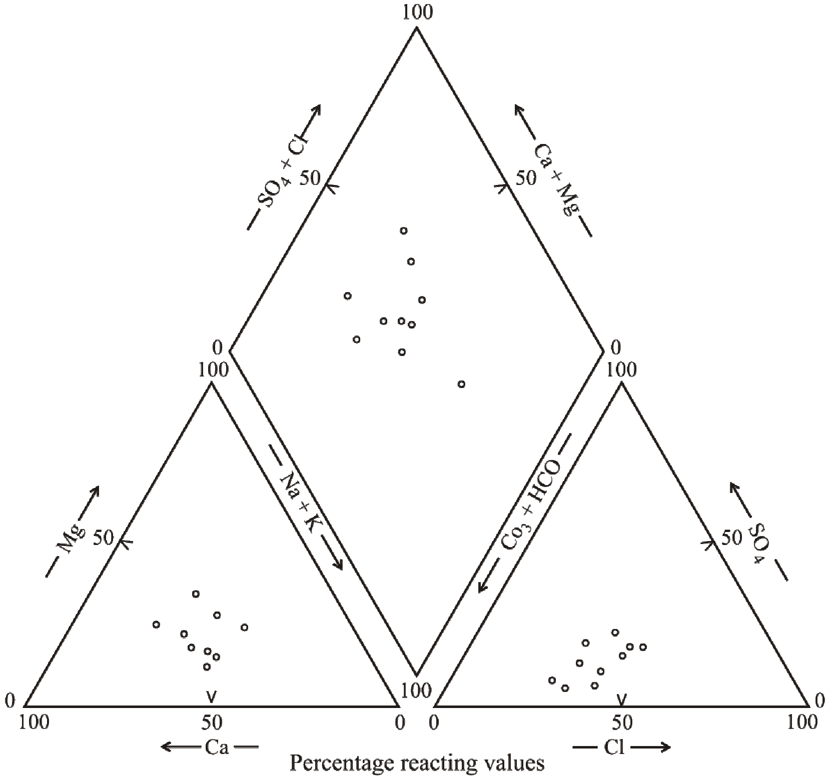

Fig. 4: Piper diagram for chemical classification of water

Based on Gibbs variation (ratio – I) i. e. anions dominant and Gibbs variation (ratio – II) i. e. cation dominant nature, the groundwater samples of the area are plotted separately against respective values to know the nature of the groundwater chemistry of the area (Fig. 2 and 3).

From the graphical plots, it is found that majority samples are falling in rock dominance area indicating the major source of mineral concentration of dissolved salts are supplied from the host rocks i. e. rock derived dissolved salts.

The Piper Trilinear Diagram (PTD)[25] is most useful to understand the chemical relationships and problems about the geochemical evolution among groundwater. The chemical quality data of the investigated area are plotted on Pipers Trilinear Diagram for graphical analysis (Fig. 4). Based on Pipers diagram, the groundwater facies of the area are categorized as alkaline earths exceed alkalies and weak acids exceed strong acids and carbonate hardness exceeds 50%, i. e. chemical properties of water are dominated by alkaline earths and weak acids, few samples also show that no cation – anion pair exceed

50 percent.

CONCLUSIONS

On the basis of hydrochemical studies, it may be concluded that the quality of groundwater in certain parts of Hyderabad city is affected and not fit for human consumption. In the study area, many of ionic concentrations in the groundwater are at higher levels indicating that they are problematic in one way or the other, if they are consumed without proper treatment.

It is significant to note that groundwaters of variable quality exist in this area and the quality of the groundwater is being deteriorated in some parts. This is mainly because of percolation from sewage, waste disposal sites and industrial effluents.

Therefore, it is advisable that constant monitoring and proper treatment of groundwater is essential, as prerequisite for use of these waters for drinking purpose because of excessive amounts of fluoride and nitrate concentration in the groundwater of the area.

As the waters are of very hard type, they may pose problem for domestic use also, in particular washing of clothes because of their adverse action with soap and hence, water softening processes for removal of excess hardness is needed. If this is not feasible, it is recommended that these waters may be used only for some industrial and other purposes.

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