INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES

IJPAES

Volume-4, Issue-2, April-June-2014

ISSN 2231-4490

Coden : IJPAES www.ijpaes.com

Received: 4th Jan-2014 *Revised: 20th March-2014* *Accepted: 25th March-2014*

Research article

ASSESSMENT OF GROUND WATER QUALITY IN AND AROUND MIRYALAGUDA AREA, NALGONDA DISTRICT OF ANDHRA PRADESH

M. Venkateshwarlu[1]*, M.A.Rasheed[2]., U.V.B. Reddy[1] and A. Kiran Kumar[3]

[1]Department of Applied Geochemistry, Osmania University, Hyderabad – 500007, A.P
[2]Gujarat Energy Research and Management Institute (GERMI), Gandhinagar, Gujarat- 382007
[3]Department of Chemistry, Osmania University, Hyderabad– 500001, A.P.
*Corresponding Author E-mail: venkatmusini@gmail.com

ABSTRACT: A Geochemical study was conducted in Miryalaguda mandal of Nalgonda district, Andhra Pradesh, to assess the quality of ground water, which is mainly used for drinking purpose. Geochemical studies was conducted on 58 representative ground water samples collected in pre- and post-monsoon seasons and analyzed for various parameters like pH, EC and TH, estimation of various cations and anions like SO_4^{2-}, Ca^{+2}, Mg^{+2}, Na^{+}, K^{+}, Cl^{-}, and F^{-}. The result showed that the concentrations of these ions exceed the permissible limits of World Health Organization (WHO) and Bureau of Indian Standards (BIS) for drinking purposes. The increased concentrations of these elements pose potential sensory problem and the overall quality of the waters was found unsatisfactory for dinking purpose.
Keywords: Geochemical, Ground water, anions and cations.

INTRODUCTION

Water is basic to life and health; over 1 billion people worldwide have no access to safe drinking water [1]. Groundwater forms a major source of drinking water. In the last few decades, there has been a tremendous increase in the demand for fresh water due to rapid growth of population and the accelerated pace of industrialisation. Human health is threatened by most of the agricultural development activities particularly in relation to excessive application of fertilizers and unsanitary conditions. Rapid urbanisation, especially in developing countries like India, has affected the availability and quality of groundwater due to its overexploitation and improper waste disposal, especially in urban areas. According to WHO organisation, about 80% of all the diseases in human beings are caused by water. As the water is the most important component of eco-system, any imbalance created either in term of amount, which is presence of impurities added to it can harm the whole eco-system [2]. Nearly 12 million tons of fluoride deposits on the earth's crust are found in India. These fluoride deposits are the reason for fluorosis in 17 states of India [3]. The most seriously affected areas are Andhra Pradesh, Punjab, Haryana, Rajasthan, Gujarat, Tamil Nadu and Uttar Pradesh. In the Indian continent the higher concentration of fluoride in groundwater is associated with igneous and metamorphic rocks. It is estimated that around 200 million people, from among 25 nations of the world, are exposed to fluorosis. India and China, the two most populous countries of the world, are the worst affected. It has been estimated that 65% of India's villages are exposed to fluoride risk [3]. High groundwater fluoride concentrations associated with igneous and metamorphic rocks such as granites and gneisses have been reported from India, Pakistan, West Africa, Thailand, China, Sri Lanka and Southern Africa [4]. High fluoride concentration is found where fluoride rich volcanic rocks are common. The distribution of fluoride content in the ground water of individual states is reported on the analysis of ground water quality monitoring data. Due to its strong electro negativity, fluoride is attracted to positively charged calcium in teeth and bones. The major chemical parameter of concern is fluoride. Ground water is ultimate, most suitable fresh water resource with nearly balanced concentration of the salts for human consumption. Over burden of the population pressure and dumping of the polluted water by various industries at inappropriate place enhance the infiltration of harmful compounds to the ground water [5, 6]. The high fluoride concentration in ground water in Nalgonda district reported by many researchers [7-9].

The present study is focused on the assessment of ground water quality in and around Miryalaguda Area, Nalgonda District of Andhra Pradesh using physico-chemical parameters like pH, Electrical Conductivity (EC), Total dissolved solids (TDS), Total hardness (TH) and measured the concentrations of anions and cations such as Fluoride (F^-), Chloride (Cl^-), Sulphate ($SO4^{2-}$), Nitrate (NO_3^-), Sodium (Na^+), Magnesium (Mg^{+2}), Potassium (K^+) and Calcium (Ca^{+2}) in the ground water samples. Total 58 numbers of ground water samples were collected in both pre- and post-monsoon seasons.

STUDY AREA

The present area of investigation is Miryalaguda area of Nalgonda district which forms a part of stable peninsular shield having a granitic terrain constituting of unclassified crystal lines of pre Cambrian age. The study area comprises mainly of grey and pink granitic rocks of magmatic origin, and the latter are intrusive in the former. These rocks are highly weathered revealed by the occasional presence of boulders in plain terrain. The rainfall from the South-West, monsoon is also prevented. The study area lies between longitudes 79º 30'-79º 40' E and latitudes 17º 50' – 17º 55' N and fall in the survey of India Topo sheet No. 56P/9 (Fig.1).

Tropical climate in this area causes variation in temperature, ranging from 42ºC to 47ºC as the absolute maximum with very hot and dry summers. The months of May and June are driest in the year and the temperature may rise to more than 47ºC. The rainfall starts at the middle of June or early July due to the onset of southwest monsoon. Most of the rainfall will be in the months of August and September. The winters are cold and the temperature drops to 12ºC.

MATERIALS AND METHODS

Fifty-eight groundwater samples collected from bore wells in Miryalaguda Mandal during pre-monsoon and post-monsoon periods for the months of December-2006 and May-2007 The sample locations are given in Figure 2. Various experiments were carried out to calculate parameters like pH, electrical conductivity, total dissolved solids, concentrations of Calcium, Magnesium, Sodium, Potassium, Chlorides and Sulfates were determined as per the standard methods [11]. Fluoride ion concentration was analyzed with Spectrophotometer by Zirconium Alizarin, Red-S method.

RESULTS AND DISCUSSION

Physico-chemical properties of water samples

The pH of ground water samples in pre-monsoon ranged from 7.94 to 8.74 and post monsoon ranged from 7.18 to 8.47. According to the World Health Organization (WHO) and Indian standards Institute (BIS) for permissible limits for drinking water quality of pH is 6.5 to 8.5. Thus, the pH in the study area was found to be within the permissible limits of WHO and BIS. The statistical analysis of physico-chemical properties of the ground water samples collected in pre- and post-monsoon in the study area are given in Table 1. The electrical conductivity (EC) of ground water samples in pre-monsoon ranged from 483 to 1948 and post monsoon ranged from 370 to 1972 µS/cm. The EC in the study area was found to exceed the permissible limits of WHO and BIS (1500 µS/cm). The Total dissolved solids (TDS) in water samples in pre-monsoon ranged from 100 to 790 and post monsoon ranged from 125 to 1690 ppm. The TDS in the waters of the study area exceed the permissible limit of WHO and BIS (< 600 ppm). The total hardness (TH) in ground water samples in pre-monsoon ranged from 100 to 790 mg/L and post monsoon ranged from 125 to 1690 mg/L. Permissible limit of total hardness in drinking water is 200 mg/L (WHO, 2004). Granitic rocks significantly contribute to groundwater hardness [12] made similar observation. In the pre-monsoon 48.27% and post-monsoon 87.93% of the ground water samples exceed the permissible limits prescribed for drinking purposes. The hardness of groundwater is due to the presence of alkaline earths elements such as Calcium and Magnesium. The concentration of fluoride (F^-), chloride (Cl^-), sulphate ($SO4^{2-}$), nitrate (NO_3^-), Sodium (Na^+), Magnesium (Mg^{+2}), Potassium (K^+) and Calcium (Ca^{+2}) in the ground water samples collected in pre-monsoon and post-monsoon are presented in Table 1 and 2.

The concentration of Fluoride in ground water samples in pre-monsoon ranged from 0.3 to 0.6 and post-monsoon ranged from 0.5 to 2.0 mg/L. The BIS permissible limit of fluoride is specified as 1.5 mg/L for drinking water. The samples exceed the permissible limits of BIS. As per the desirable and maximum permissible limit for fluoride in drinking water suggested by WHO [13] and BIS [12], groundwater samples in the study area were found unfit for drinking purposes. Major health problems caused by fluoride are dental fluorosis, teeth mottling, skeletal fluorosis and deformation of bones in children as well as adults. Fluoride exposure disrupts the synthesis of collagen and leads to the breakdown of collagen in bone, tendon, muscle, skin, cartilage, lungs, kidney and trachea. Fluoride stimulates granule formation and oxygen consumption in white blood cells, but inhibits these processes when the white blood cell is challenged by a foreign agent in the blood. Moreover, dental and skeletal fluorosis is found at an alarming rate among the local residents of these areas [7, 8].

The results from this study have documented the distribution of groundwater fluoride in the Nalgonda district, which is due to the presence of fluoride bearing minerals in host rocks and their interaction with water is considered to be the main cause for fluoride in groundwater [15- 17].

Table 1. The statistical analysis for Pre-monsoon ground water samples of the study area.

	Minimum	Maximum	Mean	Permissible limits of BIS (1991)	Permissible limits of WHO (2004)
pH	7.94	8.74	8.19	6.5 to 8.5	6.5 to 8.0
EC (µS/cm)	438	1948	1199.86	1500	1500
TDS (mg/L)	280	1247	768.40	< 600	< 600
TH (mg/L)	100	790	233.97	200	200
F^- (mg/L)	0.3	0.6	0.45	1.5	1.5
Cl^- (mg/L)	43	458	190.22	250	200
NO_3^- (mg/L)	2	26	9.10	45	50
SO_4^{2-} (mg/L)	18	86	43.45	200	200
Na^+ (mg/L)	0	1151	79.64	< 20	< 20
Mg^{+2} (mg/L)	1	112	22.65	30	30
K^+ (mg/L)	1	24	4.83	10	10
Ca^{+2} (mg/L)	8	464	58.66	75	75

Table 2. The statistical analysis for Post-monsoon ground water samples of the study area.

	Minimum	Maximum	Mean	Permissible limits of BIS (1991)	Permissible limits of WHO (2004)
pH	7.18	8.47	7.87	6.5 to 8.5	6.5 to 8.0
EC (µS/cm)	370	1972	1164.90	1500	1500
TDS (mg/L)	236	1322	748.43	< 600	< 600
TH (mg/L)	125	1690	558.97	200	200
F^- (mg/L)	0.5	2.0	0.66	1.5	1.5
Cl^- (mg/L)	36	675	169.97	250	200
NO_3^- (mg/L)	2	338	21.97	45	50
SO_4^{2-} (mg/L)	5	113	13.72	200	200
Na^+ (mg/L)	22	8395	213.33	< 20	< 20
Mg^{+2} (mg/L)	1	147	54.12	30	30
K^+ (mg/L)	1	54	3.672	10	10
Ca^{+2} (mg/L)	20	514	137.24	75	75

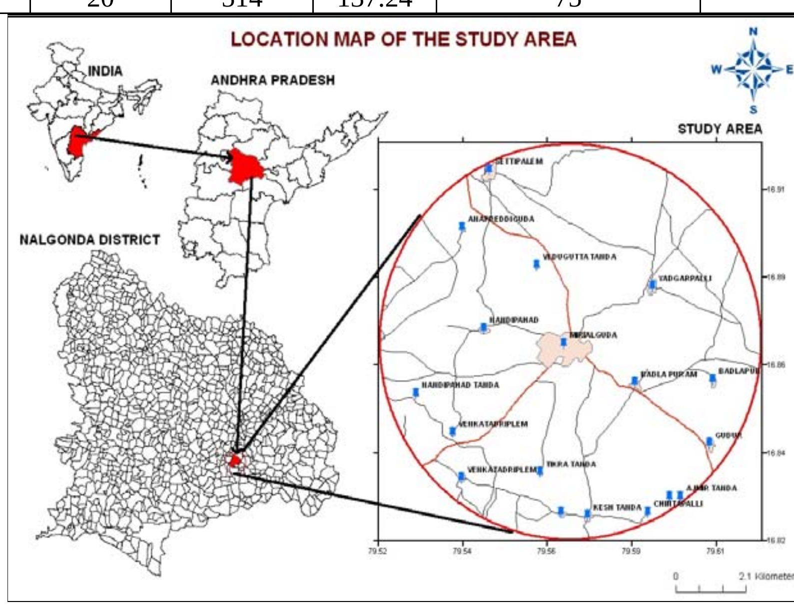

Fig.1.The location map of Miryalaguda study area, Nalgonda District of Andhra Pradesh, India.

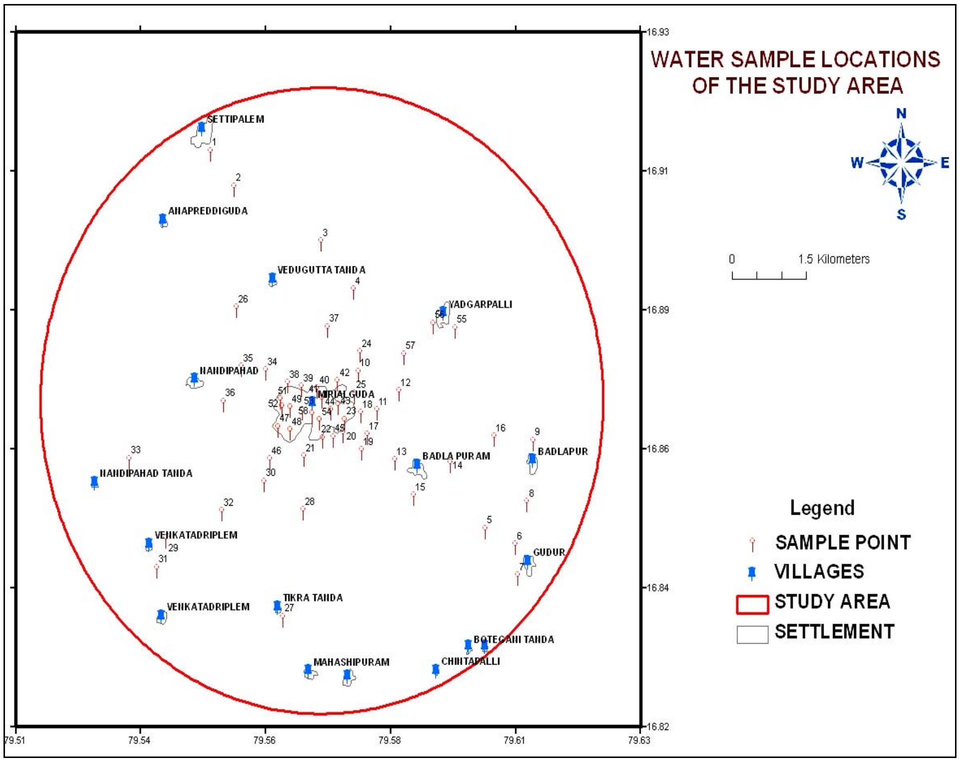

Fig.2.The Sample location map of the Miryalaguda study area, Nalgonda District.

The concentration of Chloride in the ground water samples in pre-monsoon ranged from 43 to 458 mg/L and post monsoon ranged from 36 to 675 mg/L, while the BIS permissible limit of chloride is specified as 250 mg/L for drinking water. The Chloride concentration distribution map of pre-monsoon and post monsoon seasons are shown in Figure 3a & 3b. A role for Chloride in sodium-sensitive hypertension has been proposed, which seems to indicate that both sodium and chloride are required for a hypertensive effect [17, 18]. Chloride is generally present at low concentrations in natural surface waters. It is highly soluble in water and moves freely with water through soil and rock.

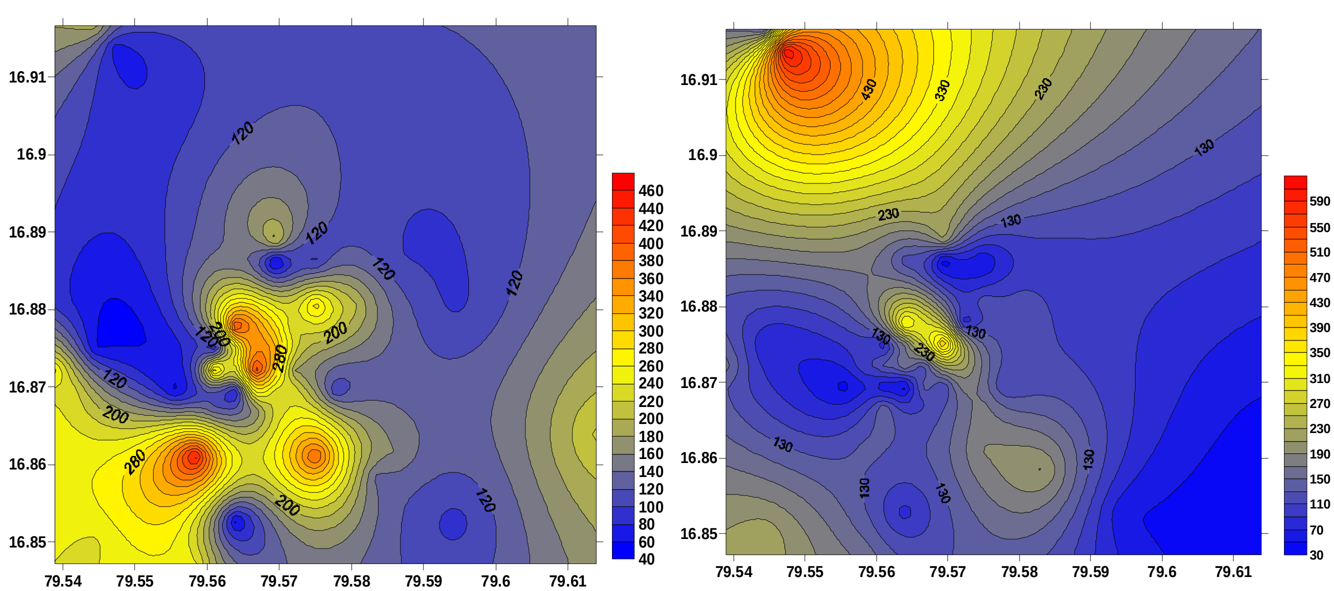

Fig 3a & 3b. The Cl (Mg/L) concentration distribution maps of pre-monsoon and post-monsoon seasons.

The concentration of NO_3^- in the ground water samples in pre-monsoon ranged from 2 to 26 mg/L and post-monsoon ranged from 2 to 338 mg/L. The BIS permissible limit of NO_3^- is specified as 45 mg/L for drinking water. The effects of exposure to nitrates in drinking water on the incidence of birth defects have been evaluated in several epidemiologic studies [17]. Nitrates and nitrites are known to cause several health effects. The most common effects are reactions with haemoglobin in blood, nitrite causing the oxygen carrying capacity of the blood to decrease, and nitrite causing decreased functioning of the thyroid gland. The health hazards from consuming water with nitrate are related to the direct toxicity of nitrite that is, its ability to directly oxidize haemoglobin, changing it to methemoglobin, which cannot bind oxygen. High nitrate concentration in groundwater of this area is due to leaching from indiscriminate dumping of animal waste. Anthropogenic activities like application of fertilizers for agriculture may contribute to the groundwater nitrate [21-23].

Sulphate concentrations ground water samples in pre-monsoon ranged from 18 to 86 mg/L and post-monsoon ranged from 5 to 113 mg/L. The limit for sulphate concentration for drinking water is specified as 200 mg/L. [13, 14]. All the samples are within the permissible limits. Uncontrolled observations indicate that sulfate in drinking water at concentrations exceeding 500 to 700 mg/liter is associated with diarrheal in adults and infants. The distribution of sulphate is due to sulphur minerals, sulphides of heavy metals, which occur commonly in igneous rocks and metamorphic rocks. Apart from these natural sources, sulphates can be introduced through the application of sulphatic soil conditioners. Na^+ concentration in ground water samples in pre-monsoon ranged from 0 to 1151 mg/L and post-monsoon ranged from 22 to 8395 mg/L with desirable limit of < 20 mg/L [13, 14]. The Na^+ (Mg/L) concentration distribution maps of pre-monsoon and post-monsoon seasons are shown in Figures 4a & 4b. Na^+ is involved in transmission of nerve impulses and maintenance of water, acid-base balance. Excessive intake of very high doses of sodium may cause acute effects such as nausea, vomiting, inflammatory reaction in the gastrointestinal tract, thirst, muscular twitching, convulsions, and possibly death. For long-term lower level exposures, the health effect of primary concern is hypertension. Central nervous system disturbances such as convulsions, confusion and pulmonary edema are possible [18-20].

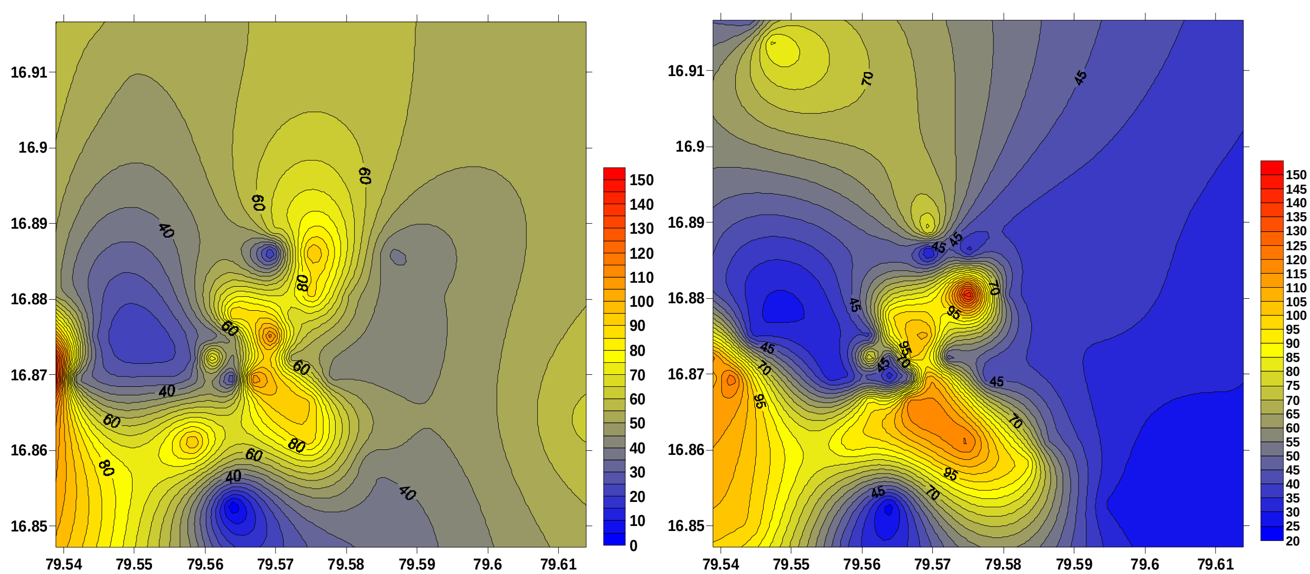

Fig 4a & 4b. The Na^+ (Mg/L) concentration distribution maps of pre-monsoon and post monsoon seasons.

The concentration of Mg^{+2} in water samples in pre-monsoon ranged from 0 to 112 mg/L and post monsoon ranged from 1 to 147 mg/L, which exceeds the permissible limit of WHO for Mg^{+2} is 30 mg/L. The Mg (Mg/L) concentration distribution maps of pre-monsoon and post monsoon seasons are shown in Fig 5a & 5b. Mg^{+2} is a cofactor for some 350 cellular enzymes, many of which are involved in energy metabolism. The major cause of hypermagnesemia is renal insufficiency associated with a significantly decreased ability to excrete magnesium. Increased intake of magnesium salts may cause a change in bowel habits (diarrhoea), but seldom causes hypermagnesemia in persons with normal kidney function. Excess magnesium concentration may lead to changes in mental status, nausea, diarrhoea, loss of appetite, muscle weakness, difficulty in breathing, extremely low blood pressure, and irregular heartbeat [18-20].

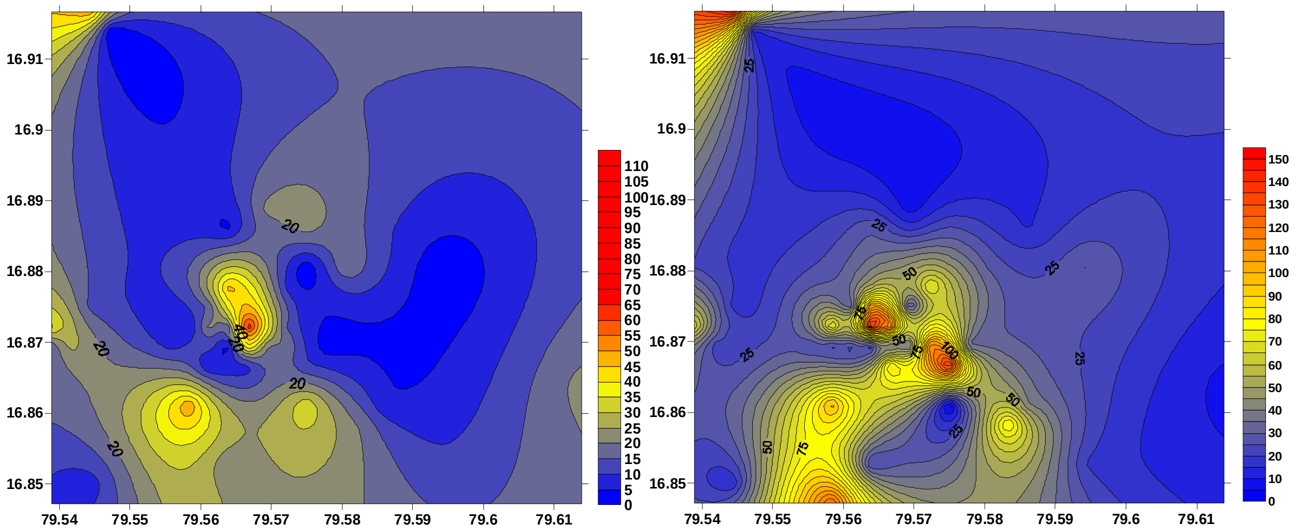

Fig 5a & 5b. The Mg^{+2} (Mg/L) concentration distribution maps of pre-monsoon and post monsoon seasons.

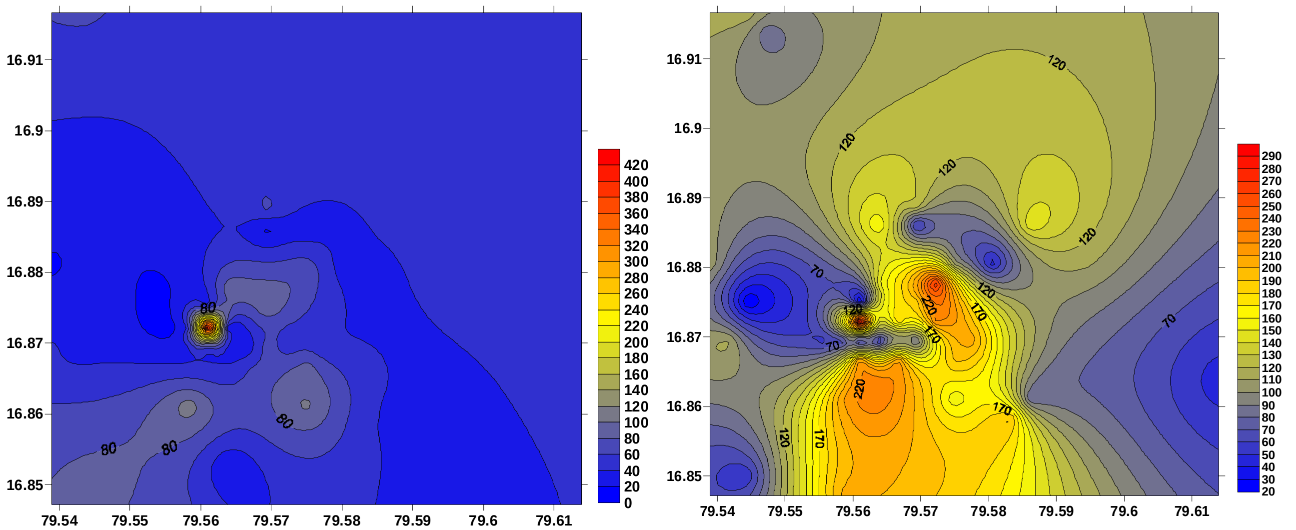

Fig 6a & 6b. The Ca^{+2} (Mg/L) concentration distribution maps of pre-monsoon and post monsoon seasons.

K^{+} concentration in pre-monsoon ranged from 1 to 24 mg/L and post monsoon ranged from 1 to 54 mg/L, which is found to be high than the permissible limit for K^{+} is 10 mg/L. Increased exposure to potassium could result in significant health effects in people with kidney disease or other conditions, such as heart disease, coronary artery disease, hypertension, diabetes, adrenal insufficiency and pre-existing hyperkalemia.

Symptoms of hyperkalemia include weak pulse rate, irregular heartbeat and nausea. Infants also have a limited renal reserve and immature kidney function and may therefore be more vulnerable [18-20]. The concentration of Ca^{+2} in the water samples in pre-monsoon ranged from 8 to 464 mg/L and post monsoon ranged from 20 to 514 mg/L, the permissible limit of Ca^{+2} is specified as 75 mg/L for drinking water. The Ca^{+2} (Mg/L) concentration distribution maps of pre-monsoon and post monsoon seasons are shown in Fig 6a & 6b. Concern for excess calcium intake is directed primarily to those who are prone to milk alkali syndrome (the simultaneous presence of hypercalcemia, metabolic alkalosis and renal insufficiency) and hypercalcemia. Although calcium can interact with iron, zinc, magnesium and phosphorus within the intestine, thereby reducing the absorption of these minerals, available data do not suggest that these minerals are depleted when humans consume diets containing calcium above the recommended. Water hardness has been related with cardio-vascular diseases, though it is not clear whether it is due to calcium and/or magnesium or because metals are more soluble in hard waters [18-20]. High Calcium concentration was observed in ground water samples.

CONCLUSIONS

Geochemical studies was conducted in the Miryalaguda Mandal of Nalgonda district on 58 representative ground water samples collected in pre- and post-monsoon seasons and analyzed for various parameters like pH, EC and TH, estimation of various cations and anions like SO_4^{2-}, Ca^{+2}, Mg^{+2}, Na^+, K^+, Cl^-, and F^-. The result showed that the concentrations of these ions exceed the permissible limits of World Health Organization (WHO) and Bureau of Indian Standards (BIS) for drinking purposes. The increased concentrations of these elements pose potential sensory problem and the overall quality of the waters was found unsatisfactory for dinking purpose.

ACKNOWLEDGMENTS

The authors express their thanks to the Head, Department of Applied Geochemistry, Osmania University, Hyderabad for providing necessary laboratory facilities. The present work was carried out as part of Ph.D research program of the corresponding author Dr. M. Venkateshwarlu, Research Scholar, Osmania University, Hyderabad.

REFERENCES

[1] Peeler, K. A. Opsahl, S. P. Chanton J. P 2006. Tracking Anthropogenic Inputs Using Caffeine, Indicator Bacteria and Nutrients in Rural Freshwater and Urban Marine Systems. Environ. Sci. Technol., 40: 7616.

[2] Ranjana 2009. Study of Physico-chemical Parameters of Ground Water Quality in Dudu Town in Rajasthan. Rasayan Journal, 2, 4: 969.

[3] UNICEF 1999. States of the Art Report on the Extent of Fluoride in Drinking Water and the Resulting Endemicity in India. Report by Fluorosis and Rural Development Foundation for UNICEF, New Delhi. Environmental Monitoring and Assessment, 145:1–65.

[4] WHO 2006. Fluoride in drinking water. London, UK: IWA publishing.144.

[5] Rajashekara P M, Sharmila Banu G, Kumar and Smila K H 2005. Physico-chemical characteristics of drinking water in selected areas of Namakkal town, Tamil Nadu, India. Indian J. Environmental Protection, 10, 3: 789-792.

[6] Rajan M R, and Paneerselvam I 2005. Evaluation of drinking water quality in Dindigul city, Tamil Nadu. Indian J. Environ. and Ecoplan, 10, 3: 771-776.

[7] Ayoob S, and Gupta A K 2006. Fluoride in drinking water: A review on the status and stress effects. Environ Monit Assess Critical Reviews in Environmental Science and Technology, 36: 433–487.

[8] Ibrahim M, Asim Rasheed, Sumalatha M. and Prabhakar P 2011. Effects of Fluoride Contents in Ground Water: A Review. International Journal of Pharmaceutical Applications, 2, 2: 128-134.

[9] Pillai K S and Stanley V A 2002. Implications of fluoride an endless uncertainty. Journal of Environmental Biology, 23: 81–87.

[10] Subba Rao N 2005.Groundwater quality: Focus on fluoride concentration in rural parts of Guntur district, Andhra Pradesh, India. Hydrological sciences, 48, 5: 835–847.

[11] APHA 1985. American Public Health Association, Standard Methods for the Examination of water and waste, 16th Edn.,Washington, D.C.

12] Jain C K and Sarma M K 1996, Fluoride contamination in Groundwater of Jodhpur District, Rajasthan Journal of Applied Hydrology, 14, 2: 11-17.

[13] WHO 2004. Guidelines for Drinking Water Quality. 1. World Health Organization.

[14] Bureau of Indian Standard (BIS) 1991. Indian standard specification for drinking water. p.2–4.

[15] Narsimha A, Sudarshan V, Srinivasulu P, Geetha S and Rama Krishna B 2012. Major ion chemistry of groundwater in rural area of Kattanguru, Nalgonda District, Andhra Pradesh, India, Advances in Applied Science Research, 3, 6: 4003-4009.

[16] Reddy D V, Nagabhushanam P, Sukhija B S, Reddy A G S, and Smedley P L 2010. Fluoride dynamics in the granitic aquifer of the Wailapally watershed, Nalgonda District, India. Chemical Geology, 269: 278-289.

[17] Bala Chennaiah J, Rasheed M.A, Lakshmi M, Dayal A M and Patil D J 2013. Assessment of Ground Water Quality in Ghatkesar and Bibinagar Areas of Andhra Pradesh, India. International Journal of Plant, Animal and Environmental Sciences. 3, 4: 123-130.

[18] Rasheed M.A., Lakshmi M., Patil D.J., and Dayal A.M 2010. Assessment of drinking water quality using ICP-MS and Microbiological methods in Bholakpur area, Hyderabad, India. Environmental Monitoring and Assessment. 184:1581–1592

[19] Rasheed M.A., Srinivasa Rao P.L., Anuradha B., Lakshmi M., and Dayal A.M 2011. Assessment of Groundwater Quality using ICP-MS in the eastern region of Adilabad District, Andhra Pradesh, India. "Journal of Environmental Protection and Ecology, 12, 2: 425–433.

[20] Rasheed M.A., Anuradha B., Srinivasa Rao P.L., Lakshmi M., and Dayal A.M (2012). Evaluation of potable groundwater quality in some villages of Adilabad District, Andhra Pradesh, India. Journal of Environmental Biology, 33: 689-693.
[21] Brindha K, Rajesh R, Murugan R, and Elango L 2010. Natural and Anthropogenic Influence on the Fluoride and Nitrate concentration of groundwater in parts of Nalgonda District, Andhra Pradesh, India Journal of Applied Geochemistry, 12, 2: 231-241.
[22] Croen L A, Todoroff K, and G M Shaw 2001. Maternal exposure to nitrate from drinking water and diet and risk for neural tube defects. American Journal of Epidemiolgy, 153:325–331.
[23] Brindha K, Rajesh R, Murugan R and Elango L 2012. Nitrate Pollution in Groundwater in Some Rural Areas of Nalgonda District, Andhra Pradesh, India. J Environ. Science and Engg. 50, 1: 64-70