IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 7, Issue 6, Dec - Jan, 2020
ISSN: 2320 – 8791 (Impact Factor: 2.317)
www.ijreat.org

HIGH FLUORIDE CONCENTRATION OCCURRENCE IN VANGAPERU BASIN, ANANTHAPURAMU DISTRICT, ANDHRAPRADESH, SOUTH-INDIA.

P. Rajasekhar Reddy [#1], Dr.S. Ramanaiah [#2], U. ImranBasha [#3].

#1. Department of Geology, Sri Venkateswara University, Tirupati, Andhra Pradesh, India.
#2. Professor, Department of Geology, Sri Venkateswara University, Tirupati, Andhra Pradesh, India.
#3. Department of Geology, Sri Venkateswara University, Tirupati, Andhra Pradesh, India.

Abstract

High levels of fluoride (beyond 1.5 ppm) in ground water as source of drinking water are common in many parts of Ananthapuramu District, Andhra Pradesh India, and causing fluorosis. A study was carried out to determine fluoride concentration in groundwaters of Vangaperu Ananthapuramu district, Andhra Pradesh. Water samples were collected from 44 boreholes during Pre & Post monsoon conditions 2018. Samples were then analysed for fluoride by using a fluoride electrode and an ion selective meter. The results showed that fluoride concentrations for the rainy season varied from min 1.80 mg/l to max 3.8 mg/l both conditions. Majority of the samples are deseriable limits as per World Health Organisation (WHO) maximum permissible limit of 1.5 mg/l.The high groundwater fluoride values seem to be associated with the weathered basement complex containing biotite that is a probable source of fluoride. The concentration of fluoride in ground water with depth of the aquifer is a function of lithology, amount and duration of rainfall, rate of infiltration, and level of ground water exploitation in the area. According to Gibbs' ratio samples in both seasons fall in the rock dominance field. Piper diagram under falls the $CaNaHco_3$, *CaMgCl types.*

Keywords:- *Fluoride, Vangaperu Basin, Piper plot, Gibbs Diagram, South India*.

INTRODUCTION

Groundwater is an essential component of the environment and economy. It sustains the flow in our rivers and plays an important role in maintaining the fragile ecosystems. Irrigated agriculture in the state is putting additional stress on the groundwater system and needs proper management of the resources. As large parts of India particularly hard rocks have become water stressed due to rapid growth in demand for water due to population growth, irrigation, urbanization and changing life style. Therefore, in order to have an accurate and comprehensive micro-level picture of groundwater in India, aquifer mapping in different hydrogeological settings at the appropriate scale is devised and implemented, to enable robust groundwater management plans. This will help in achieving drinking water security, improved irrigation facility and sustainability in water resources development in large parts of rural and many parts of urban India concentration is an important aspect of hydro geochemistry, because of its impact on human health. The fluoride occurs mainly as sellaite (MgF2), fluorspar (CaF2), cryolite (Na3AlF6) and fluorapatite [3Ca3(PO4)2 Ca(F,Cl2)]. As fluorspar it is found in sedimentary rocks and as cryolite in igneous rocks. These fluoride minerals are nearly insoluble in water. Hence fluorides will be present in groundwater only when conditions favour their dissolution or high fluoride containing effluents are discharged to the water bodies from industries. The main potential health risks from fluoride are considered to be fluorosis or bone disease. The recommended concentration of F in drinking water is 1.50 mg L−1 (WHO 2004). In India almost 60–65 million people drink fluoride contaminated ground water and the number affected by fluorosis is estimatedat 2.5–3 million (Athavale & Das 1999). Itsdeficiency (<0.6 mg/l) causes dental caries and excess causes skeletal fluorosis (Susheela et al. 1999). The chemistry of the fluoride ions released into the groundwater is found to be controlled by the degree

of saturation of fluorite and calcite (CaCO3) with fluoride concentration related inversely to calcium and directly related to bicarbonate concentration in groundwater (Handa 1975; Nordstrom and Jenne 1977; Gaciri and Davies 1993). The studies carried out by various researchers on groundwater quality with respect to fluoride across India, including Gujarat, are reported elsewhere (Shaji et al. 2007; Asadi et al. 2007; Misra et al. 2006; Sujatha 2003; Rao and Devadas 2003; Sarma and Rao 1997; Madhnure et al. 2007; Gupta et al. 2006; Kundu et al. 2001; Barot 1998; Guptaet al. 1999). The fluoride concentration ranges from 3.42 to 4.98 mg/l in the pre-monsoons season and from3.20 to 4.85 mg/l in the post monsoon season..Fluoride concentration exceeding the desirable limits prescribed for drinking water has been found in groundwater in Villages surrounding Talupula (Rajasekhar,et.al,.2018). The primary objective of finding out the nature, cause and source of the high F in ground water of the area. In the context with India, the groundwater plays a vital role as about 30% of the urban population and 90% of the rural population still depend upon untreated groundwater for drinking and irrigation (Adimalla and Venkatayogi, 2017, 2018; Adimalla and Li, 2019).

2. Study Area

The study area is Vangaperu basin falls in Southern part of Ananthapuram district. The Vangaperu Basin is in between the North latitudes 13.98 to 14.28 and East longitudes 77.53 to 77.81. The Vangaperu basin area is 549 sq.km. This is sub basin of Chitravathi River, it is joining to Chitravathi River at 14^0 15' 43.15", 77^0 45' 36.27". The basin covers 6 mandals of which major mandals are Penukonda, Kothacheruvu, and minor portions of Puttaparthi, Somandepalli and a very little part of Gorantla, Roddam mandals. NH-7 highway is passing through this basin connecting Hyderabad and Bangalore cities. Two railway lines are passing through this basin connecting Hyderabad and Bangalore cities. Major industrial development is under progress in Penukonda and Somendepalli mandals. In this basin prestigious KIA Motors India Company is established and many more industries are in pipe line. Gollapalli reservoir is the biggest surface water storage point, and it is the main resource point to KIA Motors and also for irrigation purpose. Normal rainfall of the basin is 650 mm, which is very low in the entire State. The area receives rains through southwest monsoon, during June to September. This area is frequent drought prone area. It experiences very hot climatic conditions in the months of March to May and the temperature reaches upto 48^0C. During winter i.e., December to January the temperatures drop to 18^0 C.

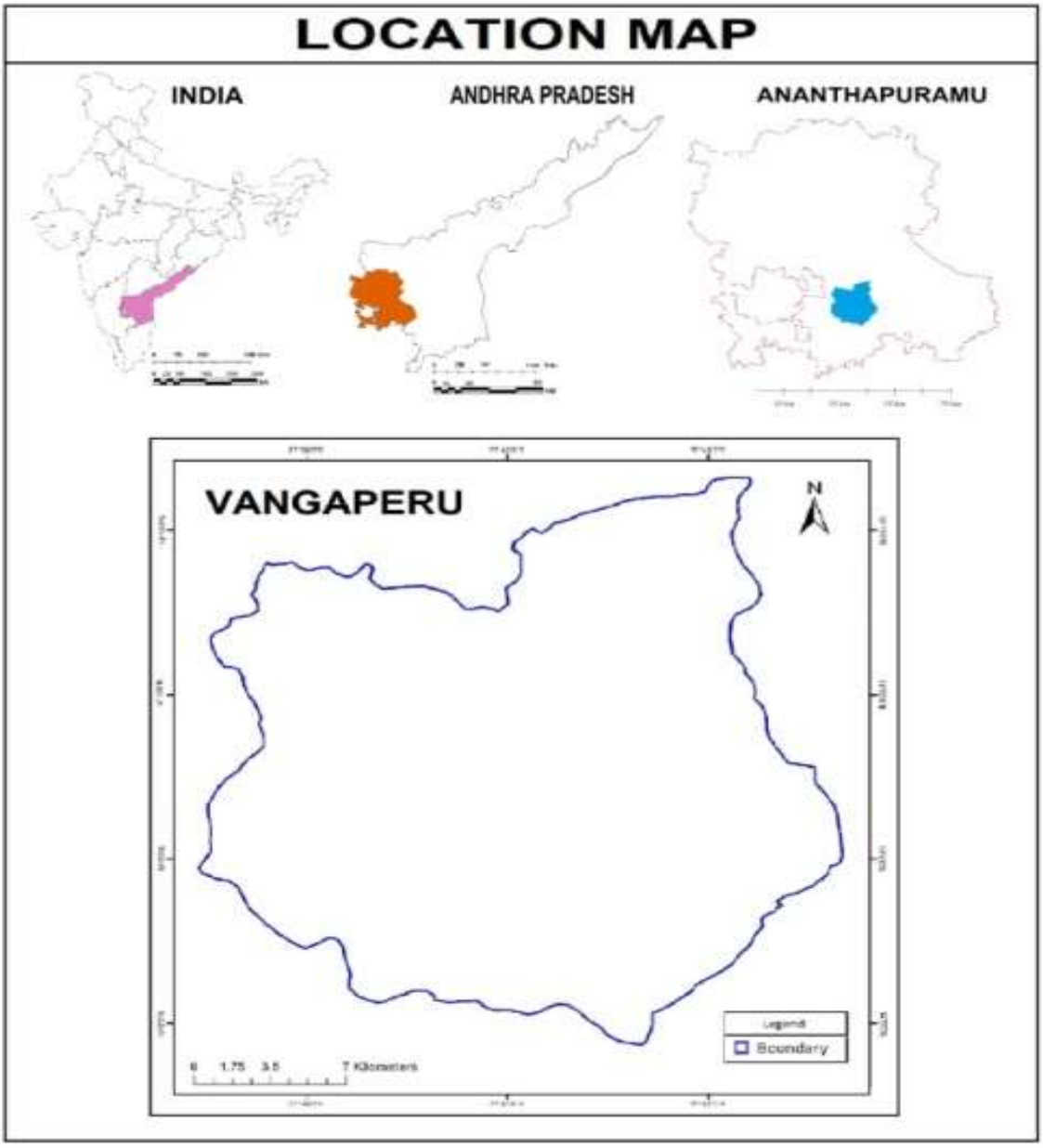

Fig .1 - Location of the Area

Geology Settings

The area mapped around Vangaperu Basin represents western part of the Eastern Dharwar Craton and is occupied by greenstone-granite gneiss/granite association represented by the Ramagiri-Penakacherla Schist Belt and associated granites and gneisses of PGC. Like in other cratonic areas of the world, the lithounits of the area are characterised by imprints of polyphase deformation, metamorphism and igneous activity. The lithounits of the Ramagiri-Penakacherla supracrustal sequence exposed are: pillowed metabasalt, metaultramafite, massive metabasalt, amphibolite/hornblende actinolite schist, actinolite chlorite schist, chlorite schist, sericite schist, crystal tuff, finely laminated feldspathic quartzite, cherty quartzite and banded magnetite haematite quartzite. The components of the PGC are grey streaky/banded tonalite-granodiorite gneiss, diorite-tonalite intrusives, amphibolitised basic dykes, migmatite gneiss-I, migmatite gneiss-II, grey porphyritic alkalifeldspar granite, granite, granodiorite, mafic (biotite-

hornblende) rich medium grained granite, coarse to very coarse grained mafic poor grey and pink granite, fine to medium grained grey and pink granite, aplite and quartzo feldspathic pegmatites. The quartz tourmaline veins, quartz veins of greasy grey, bluish grey, milky white and ferrugenous nature and the dolerite, gabbro and dunite dykes represent younger intrusive in the area.

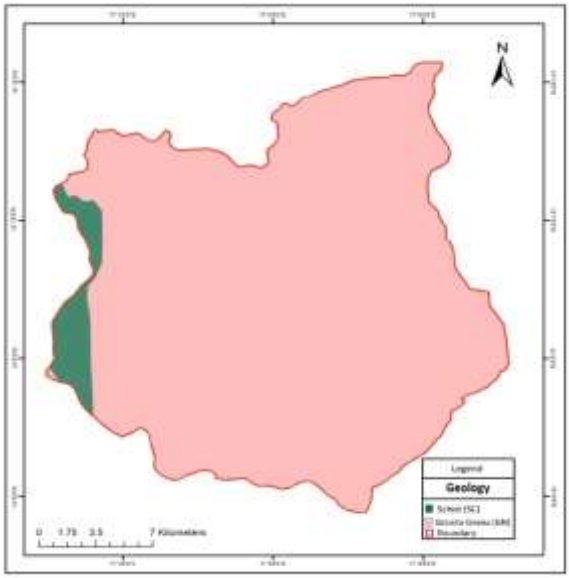

Fig: 3 - Geology Map

Materials & Methods:

A total of 44 groundwater samples were collected from Pre & Post monsoon seasons - 2018 and from bore in an area that is spread across 549 km2 in Vangaperu Basin (Fig. 1). pH, electrical conductivity, total hardness, total dissolved solids, important cations such as calcium, magnesium, sodium, and potassium and anions, such as carbonates, bicarbonates, chlorides, nitrates, and sulphates, were determined as per standard methods (Rainwater and Thatcher 1960; APHA 1995). Fluoride concentration is measured by using the ion electrode method.

Table 1. Concentration of major ions in Groundwater during pre -monsoon

Results in mg/L (* MicroSeimen/cm)																
Sl.	**Location/Village**	**Mandal**	**PH**	**E.C.**	**TDS**	**Ca**	**Mg**	**Na**	**K**	**HCo3**	**Co3**	**F**	**So4**	**Cl**	**NO3**	**Fe**
1	Ammavarupalli	Penukonda	7.61	1430	915	18	87	221	10.9	243	88	2.40	34	153	4.7	0.06
2	Bandlapalli	Kothacheruvu	8.20	891	570	18	43	130	9.9	253	38	2.77	29	62	3.9	0.10
3	Battalapalli	Puttaparthi	7.65	1131	724	26	62	148	8.3	243	122	3.00	65	94	2.4	0.10
4	Bojjireddypalli	Penukonda	7.81	694	444	10	62	60	7.7	163	122	1.80	50	193	8.9	0.09
5	Bussaiahgaripalli	Somandepalli	7.61	934	598	26	38	118	6.6	223	82	1.82	32	161	11.1	0.07
6	Byrapuram	Kothacheruv	7.8	132	845	18	53	26	13.	443	142	2.8	38	62	3.8	0.1

		u	3	0				1	0			5				2
7	Cherlopalli	Penukonda	7.31	652	417	42	19	54	4.6	183	156	2.70	5	465	12.5	0.09
8	Duddebanda	Penukonda	7.21	1254	803	26	67	220	33.9	443	128	3.80	20	321	9.3	0.06
9	Erramanchi	Penukonda	7.41	2364	1513	266	174	107	25.6	73	70	2.42	58	257	7.9	0.11
10	Gollapalli	Penukonda	8.41	1120	717	18	53	207	13.3	353	142	1.80	20	209	16.9	0.07
11	Gondipalli	Penukonda	8.21	1645	1053	18	48	360	10.9	703	98	2.80	40	249	21.3	0.08
12	Gonipeta	Penukonda	7.61	1154	739	18	38	200	11.7	243	122	2.24	34	185	4.7	0.09
13	Gutturu	Penukonda	7.61	1086	695	26	57	175	10.0	213	62	1.80	12	569	5.7	0.09
14	Haripuram	Penukonda	7.21	885	566	26	38	104	5.7	313	218	2.44	22	137	4.7	0.11
15	Irragampalli	Kothacheruvu	7.70	1452	929	26	77	260	23.0	463	38	2.89	26	57	3.8	0.11
16	Jagarajupalli	Puttaparthi	7.87	653	418	18	19	87	2.7	153	122	2.94	72	77	3	0.06
17	K.Locherla	Kothacheruvu	7.83	992	635	18	14	207	4.6	173	38	2.89	82	57	4.4	0.14
18	K.Nagireddypalli	Kothacheruvu	8.21	978	626	34	38	104	9.9	293	88	2.70	57	57	3.9	0.11
19	Kappalabanda	Puttaparthi	8.22	1143	732	98	72	55	16.4	143	29	2.70	80	77	3.7	0.12
20	Kodapaganipalli	Kothacheruvu	8.22	771	493	10	33	110	6.6	153	88	2.79	74	88	2.8	0.11
21	Kondampalli	Penukonda	7.41	1574	1007	34	82	237	14.0	263	92	2.04	38	257	19.7	0.06
22	Kotlapalli	Puttaparthi	7.91	936	599	18	28	192	11.2	203	102	2.77	51	71	2.9	0.09

23	Makkajipalli	Penukonda	7.81	1150	736	26	33	265	17.2	543	74	2.90	16	137	15.3	0.07
24	Marakuntapalli	Kothacheruvu	7.87	545	349	10	19	67	9.9	83	62	2.90	38	77	3.7	0.11
25	Motuvaripalli	Penukonda	7.21	949	607	26	43	181	8.0	263	29	2.58	16	281	5.9	0.06
26	Munimadugu	Penukonda	7.21	990	634	34	43	192	12.7	253	38	2.04	42	537	8.7	0.13
27	Naginayanicheruvu	Somandepalli	7.61	549	351	34	9	61	4.9	163	74	2.57	10	257	7.1	0.09
28	Nidimamidi	Puttaparthi	8.21	782	500	34	19	109	7.9	303	36	3.10	44	77	2.6	0.12
29	Obulapuram	Penukonda	7.21	786	503	18	57	61	3.6	293	106	2.24	35	329	4.1	0.07
30	Pedaballithanda	Puttaparthi	7.99	1689	1081	90	101	131	18.3	93	54	3.02	80	77	3	0.08
31	Penukonda	Penukonda	7.41	1124	719	18	62	174	12.7	243	162	2.68	20	225	13.1	0.09
32	Pothukunta	Kothacheruvu	8.21	1163	744	26	9	275	12.2	353	38	2.90	68	108	3.5	0.08
33	Rachavaripalli	Puttaparthi	8.20	1450	928	90	87	207	16.7	103	122	2.80	31	77	2.9	0.11
34	Rampuram	Penukonda	7.21	850	544	10	53	107	4.6	233	164	1.80	16	257	14.1	0.07
35	Settipalli	Penukonda	7.41	645	413	42	38	70	4.7	193	156	2.80	22	201	12.3	0.07
36	Somandepalli	Somandepalli	7.61	2853	1826	122	140	392	43.5	263	92	2.68	62	289	10.5	0.09
37	Talamarla	Kothacheruvu	7.91	745	477	26	48	57	11.7	223	38	2.99	71	88	2.9	0.08
38	Timmapuram	Penukonda	7.41	784	502	50	38	58	5.7	243	70	1.80	28	129	14.5	0.06
39	Tippabatllapalli	Kothacheruvu	8.21	967	619	18	43	164	10.2	413	20	2.79	50	91	3	0.12

40	Velagamakulapalli	Somandepalli	8.01	1250	800	50	135	81	8.3	193	88	2.90	34	185	10.5	0.06
41	Vemulatipalli	Kothacheruvu	8.00	1640	1050	66	33	331	16.9	113	56	3.02	51	71	3.8	0.11
42	Venkatagiripalli	Puttaparthi	7.81	1340	858	26	72	182	26.3	353	122	2.82	80	91	2.9	0.06
43	Venkatagiripalyam	Penukonda	7.81	1460	934	18	53	290	17.2	443	182	1.80	24	257	15.3	0.07
44	Yerrapalli	Kothacheruvu	8.21	1050	672	34	53	148	14.3	213	38	2.89	46	65	4.1	0.07

Table 2. Concentration of major ions in Groundwater during post -monsoon

Results in mg/L (* MicroSeimen/cm)

Sl.	**Location/Village**	**Mandal**	**PH**	**E.C**	**TDS**	**Ca**	**Mg**	**Na**	**K**	**HCo3**	**Co3**	**F**	**So4**	**Cl**	**NO3**	**Fe**
1	Ammavarupalli	Penukonda	7.21	1021	653	10	38	246	3.5	523	70	1.80	25	181	9.1	0.09
2	Bandlapalli	Kothacheruvu	8.02	978	626	26	48	124	5.5	193	20	2.60	80	82	3.3	0.10
3	Battalapalli	Puttaparthi	7.51	545	349	18	19	67	3.1	213	54	2.71	30	71	2.9	0.08
4	Bojjireddypalli	Penukonda	7.61	684	438	26	23	54	2.5	123	106	2.60	19	305	9.5	0.15
5	Bussaiahgaripalli	Somandepalli	7.41	879	563	26	28	146	2.5	373	70	2.80	27	201	7.9	0.07
6	Byrapuram	Kothacheruvu	7.53	912	584	34	57	79	6.8	213	98	2.50	66	77	2.8	0.09
7	Cherlopalli	Penukonda	7.61	754	483	26	43	49	5.9	243	88	3.00	46	257	14.1	0.13
8	Duddebanda	Penukonda	7.71	1082	692	26	67	138	25.0	143	98	2.22	23	249	11.9	0.05
9	Erramanchi	Penukonda	8.01	976	625	58	48	69	3.5	123	36	2.54	38	297	5.8	0.28

10	Gollapalli	Penukonda	8.81	769	492	42	28	114	23.3	333	88	1.88	54	185	14.1	0.07
11	Gondipalli	Penukonda	8.01	841	538	42	53	27	2.1	153	70	2.20	56	257	18.9	0.25
12	Gonipeta	Penukonda	7.61	1160	742	18	43	236	6.5	323	54	2.40	22	161	8.3	0.07
13	Gutturu	Penukonda	7.41	2019	1292	26	96	396	13.5	373	29	1.84	18	233	12.3	0.09
14	Haripuram	Penukonda	7.61	974	623	26	38	82	13.8	313	200	1.82	12	305	4.5	0.11
15	Irragampalli	Kothacheruvu	7.33	891	570	34	57	48	10.5	173	20	2.90	60	79	3.5	0.06
16	Jagarajupalli	Puttaparthi	7.53	2415	1546	218	150	246	11.5	93	54	2.57	82	65	3.1	0.07
17	K.Locherla	Kothacheruvu	7.53	1497	958	18	33	416	4.5	503	20	2.75	40	99	2.8	0.09
18	K.Nagireddypalli	Kothacheruvu	7.79	1188	760	18	57	236	5.5	513	20	2.60	56	77	4.1	0.08
19	Kappalabanda	Puttaparthi	7.51	893	572	18	53	124	4.5	203	20	2.79	29	82	3.3	0.09
20	Kodapaganipalli	Kothacheruvu	7.61	2541	1626	322	154	666	17.5	613	38	2.70	42	94	3.3	0.12
21	Kondampalli	Penukonda	7.61	1203	770	26	57	130	4.2	193	56	1.80	34	377	18.1	0.07
22	Kotlapalli	Puttaparthi	8.21	874	559	50	43	92	3.9	293	36	2.57	31	99	3.3	0.11
23	Makkajipalli	Penukonda	7.41	692	443	18	43	52	17.1	143	20	2.60	18	281	20.9	0.09
24	Markuntapalli	Kothacheruvu	7.45	1099	703	74	57	104	8.7	213	92	2.90	51	71	4.4	0.10
25	Motuvaripalli	Penukonda	7.31	748	479	18	19	107	8.5	273	20	2.80	20	201	5.9	0.07
26	Munimadugu	Penukonda	7.31	2469	1580	34	111	666	10.5	513	20	2.40	34	201	10.5	0.12

27	Naginayanicheruvu	Somandepalli	7.31	893	572	18	72	75	8.5	223	130	1.80	32	233	5.1	0.11
28	Nidimamidi	Puttaparthi	7.76	1233	789	34	72	191	3.1	243	20	2.52	76	82	3.3	0.12
29	Obulapuram	Penukonda	7.81	1250	800	114	82	107	13.9	83	70	2.20	7	329	7.9	0.13
30	Pedaballithanda	Puttaparthi	7.57	2362	1512	226	116	176	7.5	93	38	2.46	80	108	4.1	0.10
31	Penukonda	Penukonda	7.81	1082	692	18	57	286	11.5	333	98	2.30	28	377	12.1	0.06
32	Pothukunta	Kothacheruvu	7.87	1005	643	26	67	134	8.1	313	20	2.50	50	77	2.9	0.10
33	Rachavaripalli	Puttaparthi	8.22	810	518	10	38	104	3.4	233	106	2.91	54	68	2.6	0.06
34	Rampuram	Penukonda	7.81	1050	672	66	72	160	8.9	143	98	2.70	22	129	9.7	0.07
35	Settipalli	Penukonda	8.01	736	471	34	28	74	4.4	213	74	2.52	22	337	4.1	0.06
36	Sommadepalli	Somandepalli	7.31	2106	1348	66	101	326	5.5	143	110	1.80	12	233	12.3	0.06
37	Talamarla	Kothacheruvu	7.90	1860	1190	50	130	246	6.5	163	54	2.90	62	91	3.3	0.08
38	Timmapuram	Penukonda	8.01	2540	1626	42	135	496	91.5	263	36	2.69	37	193	17.7	0.08
39	Tippabattlapalli	Kothacheruvu	7.41	915	586	18	43	146	6.4	313	38	2.79	52	18	3.3	0.10
40	Velagamakulapalli	Somandepalli	7.21	980	627	10	43	196	4.5	343	29	2.80	20	297	11.5	0.07
41	Vemulatipalli	Kothacheruvu	8.11	922	590	50	53	74	7.0	103	20	2.70	26	91	4.1	0.06
42	Venkatagiripalli	Puttaparthi	8.01	1195	765	18	57	196	21.5	323	54	2.80	41	99	3.5	0.06
43	Venkatagiripalyam	Penukonda	7.21	1270	813	34	53	148	43.8	213	200	2.72	22	289	6.5	0.07

44	Yerrapalli	Kothacheruvu	7.99	1368	876	26	28	296	3.5	323	20	2.61	73	94	2.8	0.07

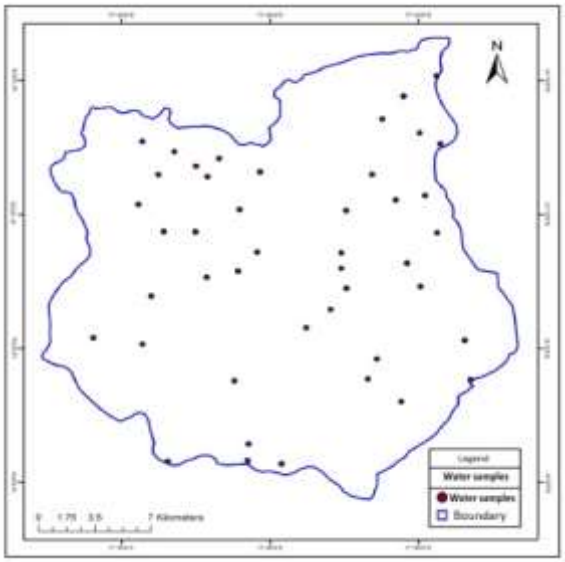

Fig: 2 - Sample Location Map

Results & Discussions

The chemical composition of ground water is derived from different sources and the relationship of ground water composition to source rock type is well known. Human activities may modify water composition extensively through direct effects of pollution and indirect results of ground water development. The study area is underlain by Granites, Gneisses and Schistose rocks which are occasionally intruded by dolerite dykes. As already mentioned, Gneisses, Schists and Granites are the predominant rock types in the area. Granite is a rock rich in quartz and having a large proportion of feldspar of which more than two-thirds of the potassium or sodium type. Gneiss and Schist resulted form heat and pressure that do not completely reorganize the initial rock. Ground water from such formations generally can be expected to be low in solute concentrations.

Table 1: Effect of prolonged use of drinking water on human health, related to fluoride content (Dissanayake1, 1991).

F_1 concentration, mg/L	Health outcome
<0.5	Dental caries
0.5–1.5	Optimum dental health
1.5–4.0	Dental fluorosis
4.0–10	Dental and skeletal fluorosis
>10.0	Crippling fluorosis

Fluoride rich minerals are fluorite, apatite, Mica, amphiboles, clay and villiaumite. In the study area the major source of F are Granites and gneissic, which has high concentration of F (1.5-3.8 mg/L) pre-post monsoon conditions shown by Tabel.1&2, Fig.4 a&b Respectively Tabel.3 showing the F Concentrations and health outcome according the thus values vangaperu basin area having the Dental caries Optimum dental health, Dental flourisis mostly affected majority region of the area respectively. The prevalence of dental fluorosis has been investigated in Rajasthan by Choubisa et al 21. (1997). Prevalence rates were observed in 40 villages with fluoride concentrations of 0.5–3.2 mg l–1. Dental fluorosis was seen in 25.6 per cent and 84.4 per cent of school children (< 16 years) and 23.9 per cent and 96.9 per cent of adults respectively (2003) examined the prevalence of dental fluorosis at lower drinking-water fluoride concentrations (mean concentrations between 1.93 and 2.14 mg l–1) in the Jhajjar district, Haryana (2003) reported dental fluorosis levels of 43 per cent in the Anantapur district of Andhra Pradesh, where drinking-water fluoride concentrations ranged between 1.2 and 2.1 mg l–1.

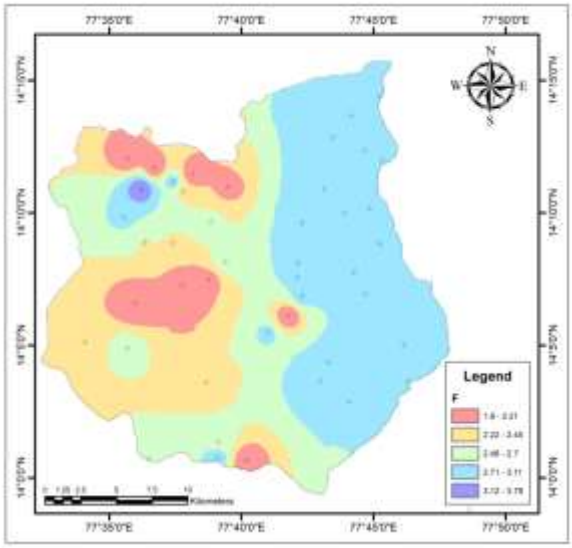

Fig. 4a Spatial Distribution Fluoride Map (Pre-Monsoon)

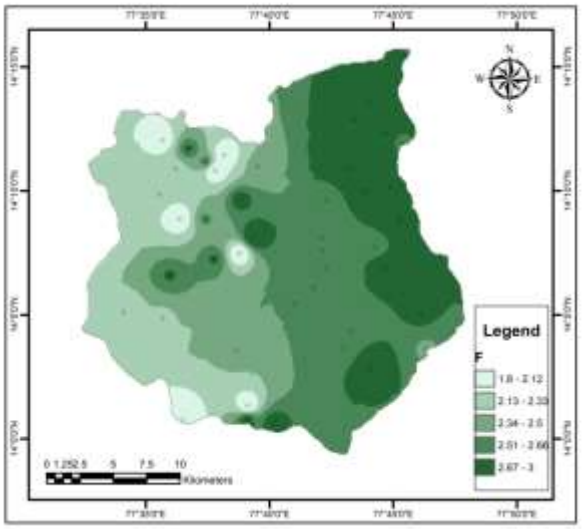

Fig: 4b - Spatial Distribution Fluoride Map (Post - Monsoon)

6. Hydro-geochemical facies and mechanisms of controlling groundwater chemistry

The major ion composition data used to classify the groundwater into various types based on the dominance of cations and anions. This will also helps in the geochemical interpretation of data as well as in understanding groundwater evolution. There are several graphical methods for displaying the major ion composition of groundwater, but the tri-linear diagram proposed by Piper widely used for geochemical interpretation of groundwater analysis data. The Piper diagram comprises two equilateral base triangles, one for plotting anion data and one for cation data and one upper diamond shaped quadrilateral for plotting combination of both cations and anions as shown in Fig. 5 a&b. The anion and cation triangles are located lower left and lower right. The bases of the triangles are aligned vertically, and the vertices point towards each other. Each vertex represents 100% of a particular ion or group of ions. Initially, the relative concentrations of major ions in percent meq/L plotted as points in each of the lower cation and anion triangles. The points extend into the central diamond-shaped quadrilateral by projecting them along lines parallel to the upper edges of the central field. The intersection of these projections represents the composition of the water concerning the combination of ions. Hydro-chemical facies are different regions with categories of cations and ion concentrations, but this concept used in different types of water helps to identify and understand the content. Based on the Piper diagram, almost 45% of the samples fall in the Mixed $CaHCO_3$ type, 5% of the samples fall in CaHco3 type, 40% of the samples fall in the Mixed Ca Mg Cl type and 10% of the samples fall in the Na Cl type during pre monsoon season.FIG;-- Based on the Piper diagram, almost 42% of the samples fall in the Mixed Ca Na HCO_3 type, 15% of the samples fall in Na Cl type, 35% of the samples fall in the Mixed CaMgCl type and 8% of the samples fall in the $CaHCO_3$ type during post monsoon season.

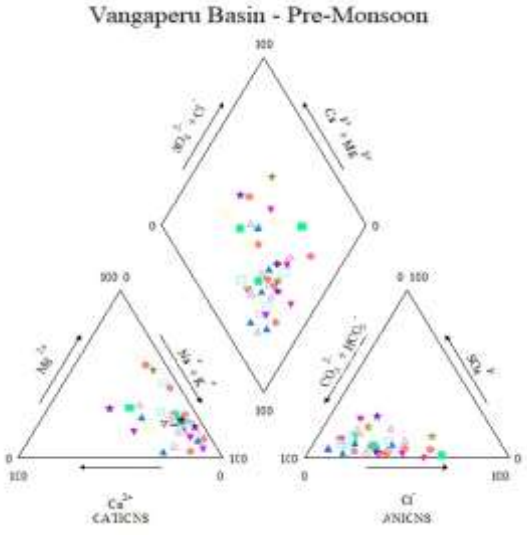

Fig: 5a - Piper plot for geochemical classification of ground water (Pre-monsoon)

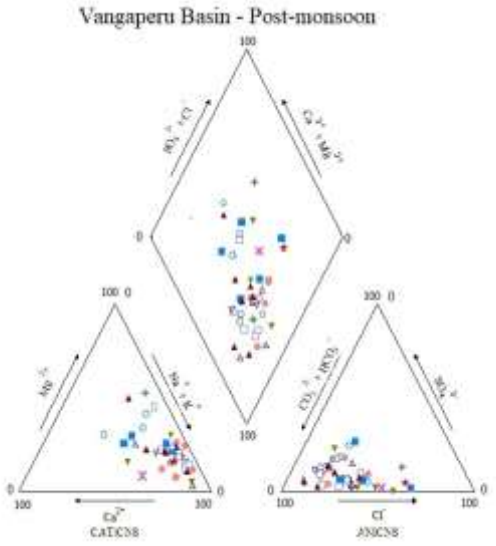

Fig: 5b - Piper plot for geochemical classification of ground water (Post-monsoon)

From the plot, alkaline earth (Ca^{2+} and Mg^{2+}) attention through alkali (Na^{+} and K^{+}), and advanced to the anion Cl^{-} not. According to Gibbs (1970) ground water composition have a close relationship with its aquifer He proposed a method to identify and quantify, rock-water interaction, precipitation and evaporation. Obtained relation will help us to understand the source and dispersal of the dissolved constituents in ground water with the major factors governing groundwater chemistry. The mechanisms responsible for controlling the groundwater chemistry is studied using Gibbs's diagram (**Fig**. 6 a&b).

The ratios: (1) (Na + K) / (Na + K + Ca)

(2) Cl / (HCO_3 + Cl)

Were plotted against TDS. Maximum points are concentrated in the central portion of Gibb's diagram in both seasons. The dominance of these points at the central portion indicates the rock and percolating water interaction in the subsurface. So we can conclude that the ground water chemistry of the study area is mainly controlled by this rock water interaction.

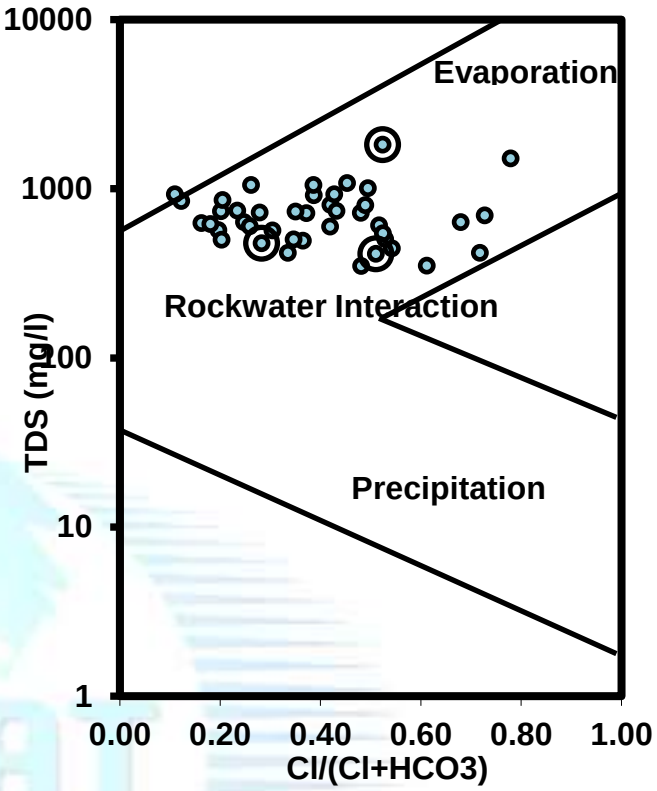

Fig: 6a - Gibbs Diagram of the study area (Pre-monsoon)

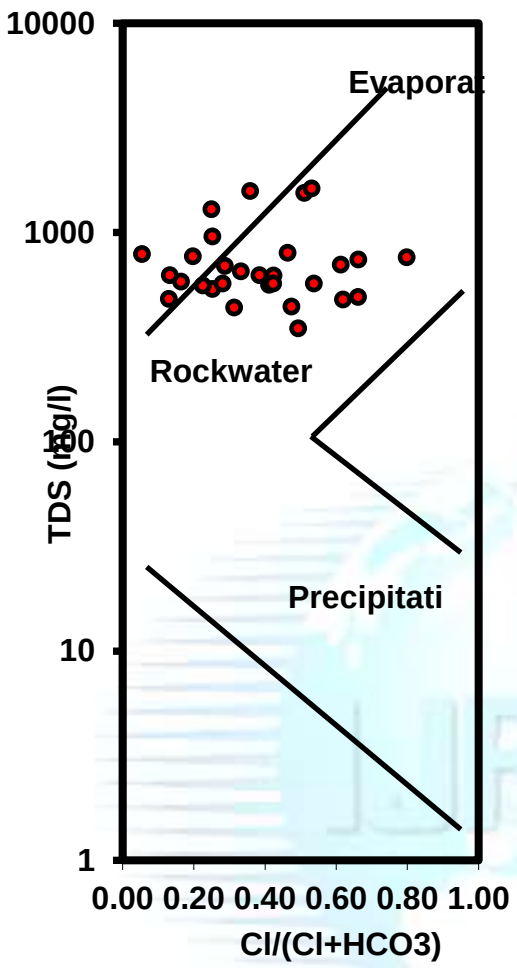

Fig: 6b - Gibbs Diagram of the study area (Post-monsoon)

Conclusions

Vangaperu basin area having the high Floiride in groundwater could lead public health issues. Therefore in this vanagaperu aera investigated 44 groundwater samples were collected and analysed from Sri Venkateswara University, Tirupathi. About 35% of the groundwater samples exceed the maximum permissible limit of fluoride (1.5 mg/l). 65% of the groundwater samples are above (1.5 mg/l) Vangaperu Basin. Majority of the area villages are affected Fluoride Concentration in Groundwater. Major ion concentrations plotted on a Piper tri-linear diagrams $CaNaHco_3$, CaMgCl types. According to Gibbs' ratio samples in both seasons fall in the rock dominance field.

8. References

1. Adimalla, N., Li, P., & Venkatayogi, S. (2018). Hydrogeochemical evaluation of groundwater quality for drinking and irrigation purposes and integrated interpretation with water quality index studies. Environmental Processes, 5(2), 363-383.

2. Adimalla, N., & Li, P. (2019). Occurrence, health risks, and geochemical mechanisms of fluoride and nitrate in groundwater of the rock-dominant semi-arid region, Telangana State, India. Human and Ecological Risk Assessment: An International Journal, 25(1-2), 81-103.

3. Adimalla, N., & Venkatayogi, S. (2017). Mechanism of fluoride enrichment in groundwater of hard rock aquifers in Medak, Telangana State, South India. Environmental Earth Sciences, 76(1), 45.

4. Asadi, G., & Mousavi, M. (2007). Application of nanotechnology in food packaging [Sitio de internet].

5. Apha, A. Wef., 1995. Standard Methods for the Examination of Water and Wastewater. 19th ed., APHA, AWWA, WEF, Washington.

6. Athavale, R. N., & Das, R. K. (1999). Beware! Fluorosis is zeroing in on you. Down to Earth, 8(6), 24-25.

7. Barot, J. S. (1998). U.S. Patent No. 5,807,244. Washington, DC: U.S. Patent and Trademark Office.

8. Dissanayake, C. B., Rao, C. R. M., & Chandrajith, R. SOME ASPECTS OF THE MEDICAL GEOLOGY OF THE INDIAN SUBCONTINENT AND REGION.

9. Gupta, A., & Anastosakos, T. (2006). U.S. Patent Application No. 11/021,237.

10. Gibbs, R. J. (1970). Mechanisms controlling world water chemistry. Science, 170(3962), 1088-1090.

11. Gupta, P. K., Gupta, P. K., & Gupta, P. K. (1999). Soil, plant, water and fertilizer analysis. Agro Botanica.

12. Gaciri, S. J., & Davies, T. C. (1993). The occurrence and geochemistry of fluoride in some natural waters of Kenya. Journal of Hydrology, 143(3-4), 395-412.

13. Handa, B. K. (1975). Geochemistry and genesis of Fluoride-Containing ground waters in india. Groundwater, 13(3), 275-281.

14. Kundu, A., Saroha, A. K., & Nigam, K. D. P. (2001). Liquid distribution studies in trickle-bed reactors. Chemical Engineering Science, 56(21-22), 5963-5967.

15. Misra, A., Kumar, P., Kamalasanan, M. N., & Chandra, S. (2006). White organic LEDs and their recent advancements. Semiconductor science and Technology, 21(7), R35.

16. Madhnure, P., Sirsikar, D. Y., Tiwari, A. N., Ranjan, B., & Malpe, D. B. (2007). Occurrence of fluoride in the ground waters of Pandharkawada area, Yavatmal district, Maharashtra, India. Current Science, 675-679.

17. Nordstrom, D. K., & Jenne, E. A. (1977). Fluorite solubility equilibria in selected geothermal waters. Geochimica et Cosmochimica Acta, 41(2), 175-188.

18. Rao, N. S., & Devadas, D. J. (2003). Fluoride incidence in groundwater in an area of Peninsular India. Environmental Geology, 45(2), 243-251.

19. Rajasekhar, M., Raju, G. S., Basha, U. I., & Raju, R. S. (2018). Determination Fluoride in Ground Water in Talupula Mandal Of Anantapur District, Andhra Pradesh, India. International Journal of Research, 5(12), 1037-1050.

20. Rainwater, F. H., & Thatcher, L. L. (1960). Methods for collection and analysis of water samples. US Government Printing Office.

21. Sarma, D. R. R., & Rao, S. L. N. (1997). Fluoride concentrations in ground waters of Visakhapatnam, India. Bulletin of environmental contamination and toxicology, 58(2), 241-247.

22. Susheela, A. K. (1999). Fluorosis management programme in India. Curr Sci, 77(10), 1250-1256.

23. Sujatha, D., & Reddy, B. R. (2003). Quality characterization of groundwater in the south-eastern part of the Ranga Reddy district, Andhra Pradesh, India. Environmental Geology, 44(5), 579-586.

24. Shaji, E., Viju, J., & Thambi, D. S. (2007). High fluoride in groundwater of Palghat District, Kerala. Current Science, 240-245.

25. World Health Organization, World Health Organization. Substance Abuse Department, World Health Organization. Department of Mental Health, & Substance Abuse. (2004). Global status report on alcohol 2004. World Health Organization.