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RESEARCH ARTICLE

CORRELATION OF FLUORIDE WITH THE OTHER IONIC CONSTITUENT IN GROUNDWATER, CHHINDWARA BLOCK, DISTRICT-CHHINDWARA, MADHYA PRADESH

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ABSTRACT

Groundwater quality in Chhindwara block has been studied with special reference to the presence of fluoride. Fluoride, above the guideline value of WHO, has been found in groundwater of the study area. This high fluoride concentration shows some type of correlation with other ionic constituents present in the ground water. The fluoride contents have positive correlation with Na^{+}, K^{+} and depth of source, and negative correlation with Mg^{+2}, Ca^{+2}, total alkalinity and total hardness. Fluoride does not show any type of correlation with Cl^{-}, NO_3^{-} and SO_4^{2-}. A few of the samples showed high nitrate contents. The sources of fluoride and nitrate are suspected to be minerals from the Precambrian granite, which forms the basement of the Chhindwara block and also outcrops at several places.

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INTRODUCTION

In order to establish the suitability of ground water for different purposes it is essential to analyze its physical, chemical and biological characteristics which are helpful in ascertaining its quality. Present day, industrialization and technological advancement have adversely affected our natural resources; specially the water resources. As industrial, agricultural and sewage wastes are being mixed with hydrological cycle causing pollution of water resources. Consumption of this polluted water has become a root cause of ill health of the people consuming it. Hence, quality study of water resources has become a matter of concern.

Chhindwara Block

Present study area is part of Chhindwara district of M.P. which falls on SOI toposheet no.55 N/4 which is bounded between latitudes $22^0$05' to $22^0$10' North and longitude $77^0$10' to $77^0$20' East. The fluoride as a contaminant has been reported from various villages of the Chhindwara district, by the workers of Central Ground Water Board and PHED of Govt. of M.P.

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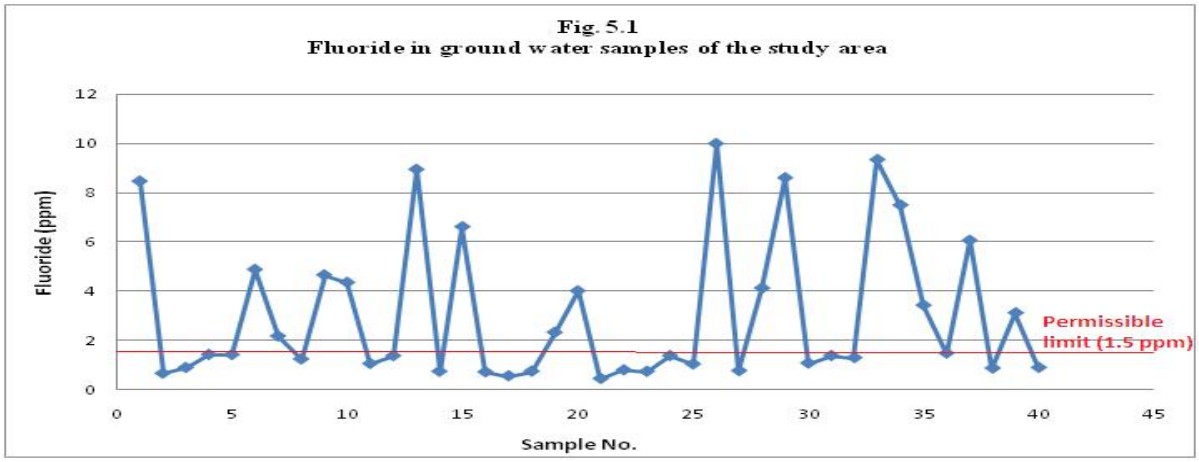
Fluoride as contaminant is not safe to consume as drinking water as it causes several health hazards. It is a common pollutant of groundwater in shallow as well as deep aquifers, where it reaches by dissolution of either the fluoride containing minerals or from other sources, fluoride in various parts of study area will be assessed and their possible sources will be delineated.

HYDROCHEMISTRY

The water samples are collected from the different parts of the study area. 40 water samples have been collected from different villages, namely, Sarna, Bangaon, Jamunia, Rajakhoh, Khakhra Chaurai, Singodi, Ramgadi, Ghat Parasia, Umaria Isra, Bhandi, Naogaon, Anjania and Chhindwara city. These water samples have been collected from different types of sources of groundwater, namely, dugwells, tubewells and handpumps. To know the hydrochemistry of groundwater of the study area, various constituents like Ca^{++}, Mg^{++}, Na^{+}, K^{+}, CO_3^{--}, HCO_3^{-}, Cl^{-}, NO_3^{-}, PO_4^{---}, and F^{-} along with the parameters like pH, EC and TH are determined (Table 1). The fluoride content in ground water samples of the study area varies from 0.433 to 10 ppm. Permissible limit of fluoride in water is 1.5 ppm according to WHO (1996). The data reveals that in most of the villages of the study area, the fluoride concentration is very much beyond the permissible limit which is mainly responsible for dental and skeleton fluorosis.

Table 1. Analysis of groundwater samples, chhindwara block, distt. Chhindwara, (M.P.)

Sam No.	VILLAGE	SOURCE	pH	EC	CO_3^{2-}	HCO_3^-	Cl^-	$SO4^{2-}$	NO_3^-	F^-	$PO4^{3-}$	TH	Ca^{+2}	Mg^{+2}	Na^+	K^+
1	Sarna	Tubewell	8.3	663	20	280	78.24	39	9.273	8.5	0.086	48	16.0	1.9	44	2.5
2	Sarna	Dugwell	8.1	865	0	748	43.03	13	63.42	0.6	0.086	396	113.8	27.2	25	2.8
3	Sarna	Handpump	8	1790	0	940	156.4	62	283.7	0.9	0.084	592	195.6	25.3	80	4.2
4	Bangaon	Tubewell	7.8	725	0	460	58.68	36	18.18	1.4	0.08	136	43.3	6.8	32	4
5	Bangaon	Handpump	7.8	1120	0	868	78.24	37	77.48	1.4	0.077	524	149.1	36.9	44.5	6
6	Jamunia	Handpump-I	7.7	754	0	716	25.43	14	40.47	4.9	0.075	280	78.5	20.4	14	3.5
7	Jamunia	Handpump-II	7.4	856	0	368	84.1	26	102.2	2.2	0.075	308	88.2	21.4	45	7
8	Rajakhoh	Handpump	7.5	822	0	752	31.29	15	64.13	1.2	0.069	360	104.2	24.3	17	4.2
9	Rajakhoh	Tubewell	7.5	666	0	760	21.51	8	5.94	4.7	0.075	236	65.7	17.5	13	3.1
10	Rajakhoh	Dugwell	7.4	659	0	680	31.29	5	2.913	4.4	0.067	228	52.9	23.3	18	3.4
11	Khakhra Chaurai	Dugwell-I	7.8	1980	0	920	224.9	66	262.9	1.0	0.052	884	320.6	20.4	122	10.1
12	Khakhra Chaurai	Main Dugwell	7.8	835	0	664	44.98	40	64.31	1.4	0.053	380	96.2	34.0	25.4	6.4
13	Khakhra Chaurai	Tubewell	8.4	452	12	224	37.16	19	2.302	9.0	0.041	32	6.4	3.9	22	4.3
14	Singodi	Handpump	7.4	1310	0	860	93.88	32	121.3	0.7	0.035	572	160.3	41.8	52	6.8
15	Singodi	Main Dugwell	7.3	458	0	428	19.56	9	11.87	6.6	0.031	120	33.7	8.7	13	3.3
16	Singodi	Dugwell-I	7.5	753	0	448	58.68	18	101.5	0.7	0.056	320	83.4	30.1	32	6.5
17	Singodi	Dugwell-II	7.4	527	0	580	17.60	6	19.4	0.5	0.026	240	70.5	15.6	11	2.8
18	Chhindwara city	Dstr. Centre	7.1	241	0	260	13.62	5	3.21	0.7	0.022	108	28.9	8.7	7.5	4.3
19	Chhindwara city	Dugwell	7.2	1470	0	1112	121.2	47	5.131	2.3	0.095	528	150.7	36.9	65	5.2
20	Chhindwara city	Tubewell	7.5	592	0	504	33.25	13	21.62	4.0	0.016	208	70.5	7.8	20	3.1
21	Ramgadi	Dugwell-I	7.6	1200	0	680	60.64	13	18.7	0.4	0.163	460	125.0	36.0	35	6.8
22	Ramgadi	Dugwell-II	7.7	1000	0	820	15.65	16	4.44	0.8	0.158	348	107.4	19.4	8.5	2.4
23	Ramgadi	Handpump	7.7	1100	0	680	39.12	48	15.15	0.7	0.148	376	107.4	26.2	24	4.5
24	Ghat Parasia	Handpump	8	1000	0	760	19.56	16	3.486	1.4	0.152	280	81.8	18.5	12	3.1
25	Ghat Parasia	Dugwell	7.8	1000	0	820	23.47	32	6.586	1.0	0.16	340	101.0	21.4	14	3.5
26	Ghat Parasia	Tubewell	7.6	800	0	428	39.12	38	0.534	10	0.149	52	14.4	3.9	22	4.4
27	Umaria Isra	Dugwell	7.5	1100	0	660	41.08	32	15.47	0.8	0.148	384	105.8	29.2	23	4.5
28	Umaria Isra	Handpump	7.3	3100	0	700	37.16	73	0.473	4.1	0.188	1240	444.0	32.1	20	3.2
29	Umaria Isra	Tubewell	7.4	900	0	304	64.55	60	0.399	8.6	0.151	32	11.2	1.0	35	6.9
30	Bhandi	Dugwell-I	8	1000	0	764	25.43	15	9.103	1.1	0.156	340	99.4	22.4	15	3.8
31	Bhandi	Dugwell-II	7.4	1100	0	780	39.12	41	7.509	1.4	0.152	368	109.0	23.3	23	4.3
32	Bhandi	Handpump	8	1000	0	620	44.99	41	1.608	1.3	0.144	172	51.3	10.7	24.5	4.8
33	Bhandi	Tubewell	7.3	800	0	412	41.08	33	0.686	9.4	0.155	36	11.2	1.9	22.5	4.5
34	Naogaon	Tubewell-I	7.6	900	0	680	21.52	25	0.32	7.5	0.147	172	51.3	10.7	12	3.2
35	Naogaon	Tubewell-II	7.5	900	0	600	29.34	33	0.393	3.4	0.137	148	40.1	11.7	17	4.1
36	Naogaon	Dugwell-I	7.8	1000	0	800	25.43	33	7.751	1.5	0.158	364	109.0	22.4	14	3.6
37	Naogaon	Dugwell-II	7.8	1400	0	860	88.02	67	15.47	6.1	0.164	484	125.0	41.8	46.5	7.7
38	Anjaniya	Dugwell-I	7.8	1000	0	760	17.6	15	9.17	0.9	0.159	340	102.6	20.4	9	2.6
39	Anjaniya	Tubewell	7.5	900	0	320	50.86	88	0.338	3.1	0.149	32	9.6	1.9	28	5.2
40	Anjaniya	Dugwell-II	7.6	1200	0	648	52.81	106	12.57	0.9	0.148	488	128.2	40.8	27.5	5.1



The Fluoride concentration of the ground water samples shown by Fig. 1.

Correlation of Different ions and other Parameters with Fluoride Concentration

Correlation with Source/Depth

The fluoride concentration shows a positive correlation with the depth or the type of source from which the sample has to be collected.

Those samples which have been collected from the shallow source of ground water like dugwell show low fluoride concentration whereas those water samples which are collected from deep source of ground water like bore well show high fluoride concentration (Fig. 2). This positive correlation of fluoride concentration with the depth of the source indicates that the source of fluoride to be fluorite or (and) apatite minerals present in the Precambrian granite or granitic-gneiss of the underground basement.

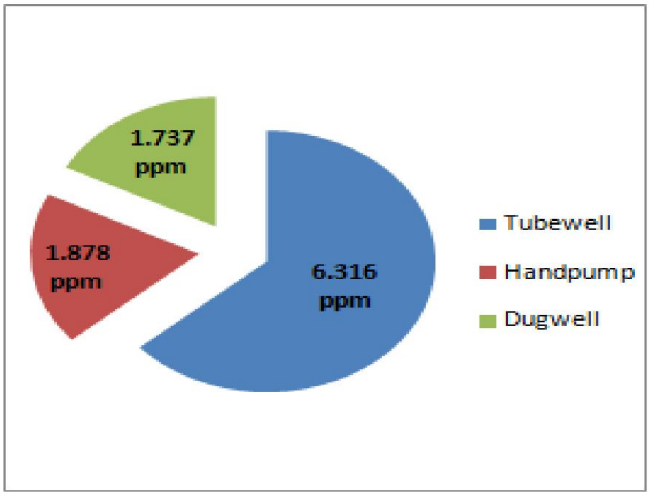
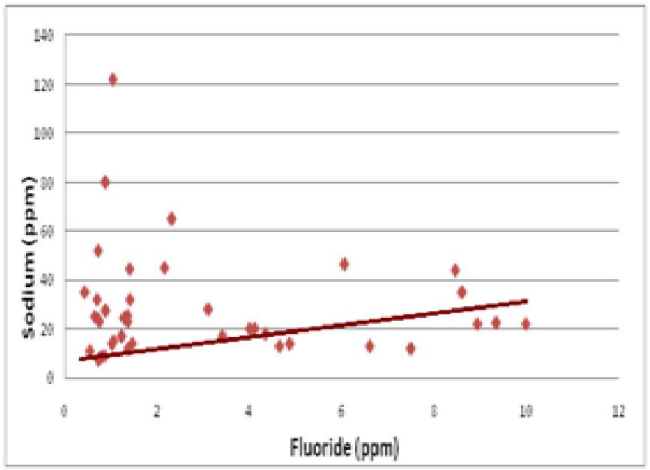


Fig. 2. Representation of average fluoride concentration in groundwater samples from different sources



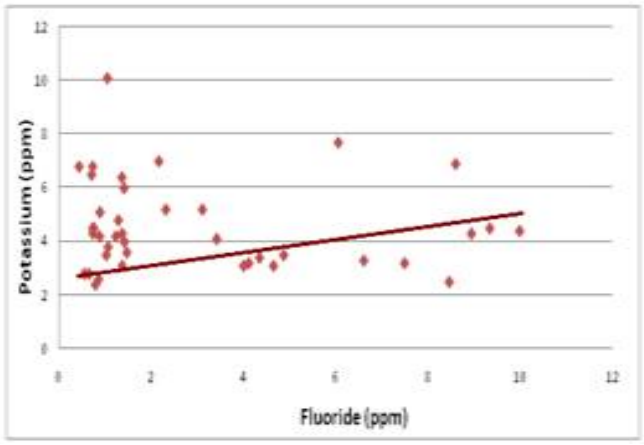
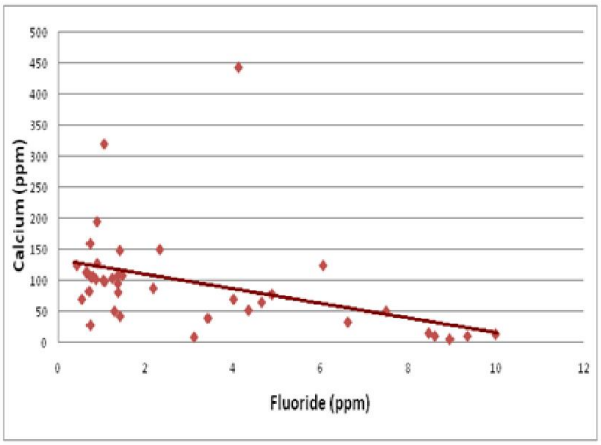
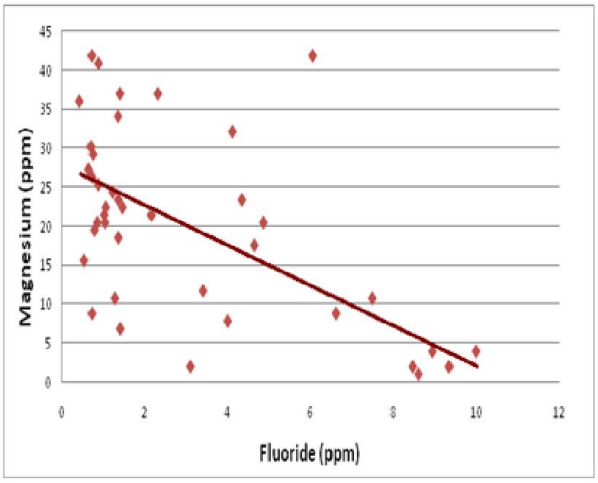


Fig. 3. Positive Correlation of ions

Correlation with other ions and parameters

The fluoride concentration also shows a positive correlation with the concentration of ions like Na^+ and K^+ (Fig. 3). Positive correlation of fluoride with Na^+ and K^+ is due to high solubility of fluorides of these ions.





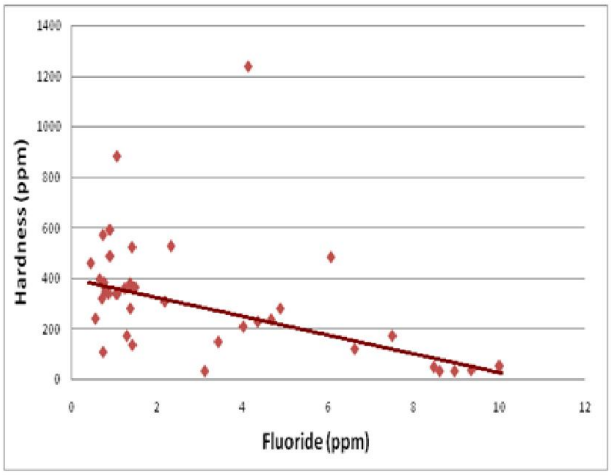


Fig. 4. Negative Correlation of ions

Negative correlation of fluoride with Mg^{+2}, Ca^{+2} is as expected due to low solubility of fluorides of these ions (Fig. 4). Some of the ions (Cl^-, NO_3^-, and SO_4^{2-}) do not show any type of correlation with the fluoride concentration.

Conclusion

The correlation of fluoride concentration with concentration of other ions present in the groundwater gives idea about the source minerals and the stablity of these source minerals in the solution form.

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