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Determination Fluoride in Ground Water in Talupula Mandal Of Anantapur District, Andhra Pradesh, India.

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ABSTRACT

The present study is aimed to evaluate the fluoride concentrations of groundwater in and around Talupula mandal of Anantapur. This study focuses in determining fluoride contents and their relationship with water quality parameters and their impact on humans. The study has been carried during pre and post monsoon conditions. Most of the area in this region is rich in fluorides endangering several eco systems. 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. It also focuses on fluorides and their relationship to water quality parameters and their impact on humans through ground water resources. The primary objective is finding out the nature, cause and source of the high Fluoride in ground water of the area.

Key words: Fluoride, Talupula, Ground water, Dental flourosis, Health issue

INTRODUCTION:

Groundwater is an imperative natural resource for the reliable and economic condition of potable water supply in both urban and rural environment. Hence it plays a fundamental role in human well-beings, as well as that of some aquatic and terrestrial ecosystems. At present, groundwater contributes around 34% of the total annual water supply and is an important fresh water resource. So, an appraisal for this resource is extremely significant for the sustainable management of groundwater systems. (G Sudarsana Raju et al., 2017). Water is an essential commodity with an un paralleled value after air and plays significant role in the biosphere (in animals and plants kingdoms), atmosphere (air) and lithosphere (rock units).It represents a unique feature in

every settlement for drinking, sanitation, washing, fishing, recreation and industrial uses (Dhanashree Nerlikar et al., 2017). Groundwater is the major drinking water source in the villages of Andhra Pradesh state. Currently, nearly 85% of Indians population is dependent on ground water for their domestic demand, particularly as source of drinking in rural areas. Groundwater also plays an important role in agriculture and nearly 140 billion m3 (BCM) of groundwater is abstracted annually for use in irrigation. Groundwater is a significant water resource in India for domestic, irrigation and industrial needs. More than 85% of rural and 50% of urban domestic water requirements are being met from groundwater resources, while irrigation accounts for around 92% of groundwater extraction(APHA, 2007) Drinking water is an important resource that needs to be protected from pollution and biological contamination. Underground water is clean but it depends upon quality and quantity of materials dispersed and dissolved in it. (G Sudarsana Raju et al., 2017). Landcover refers to the physical characteristics of the Earth's surface, captured the distribution of vegetation, water, soil and other physical features of the land, including those created merely by human activities e.g., settlements. While land-use refers to the way in which land has been used by humans and their habitat, usually with the accent on the functional role of the land for economic activities. (M Rajasekhar et al., 2017). In Anantapur area contains the world richest and high quality minerals are present such as biotite mica, feldspars minerals. The surface and ground water interact with minerals in this area leads to take pollution. This research aimed at determining water quality status of Anantapur area, such as drinking purpose, irrigation, agriculture and livestock. (G.Veeraswamy et al., 2018). India has acute public –health problem induced by utilization of ground water as a source of drinking water. The health problems arising as a result of FLOURIDE (F) contamination are far more widespread in India. In India ,approximately 60-90 millon people drink fluoride –contaminate ground water, and the number affected by flourosis is estimated at 3-6 million .In India ,the excessive presence of fluorides in ground water is present in nearly 177-200 districts covering 15 states are affected with dental ,skeletal and non-skeletal flourosis. The ground water is contaminated by excess of fluoride in 11 out of 13 districts in Andhra Pradesh, whereas all the 13 districts have areas with excess of nitrate in them. Anantapur and Srikakulam have been identified as having fluoride

levels in excess of 1.5 mg/l, which is the permissible limit as per the drinking water standards of Bureau of Indian Standards (BIS).Both Central and state Government along with various agencies (ANTHAPUR –R.D.T, other N.G.OS, UNICEF) involved in fluoride and flourosis mitigation activities since 1987 in Andhra Pradesh. The objective of the present study is to investigate the areal extent of high –fluoride concentrations in ground water well in Talupula area of Andhra Pradesh.

Study area:

The study area is located in the Survey of India Toposheet Nos: 57 A/16, 57 B/13, 57 E/4 and 57 F/1 on 1:50,000 scale and lies between east longitudes 78^0 9' 30" E 78^0 22' 30" E and north latitudes 14^0 0' 0" N to 14^0 26' 0" N (Fig.1). The study area comprises a total geographical area of 442.89 sq. km A popular investigation soil survey of Anantapur district exhibits the occurrence of exclusive soil sequence and their associations in the study area. This soil sequence can be largely classified into three categories: aridsols, alfisols and vertisol (National Bureau of Soil Survey and Land Utilization planning (NBSSLUP)). The study region is occupied wide vary of high grade metamorphic rocks of Hornblende-Gneiss/Hornblede-Biotite Gneiss. These rocks are substantially weathered and overlain with the aid of recent fills and alluvial at places. The major rock types existing in the study area are Quartzites, grey Granite/Pink granite and Rhyolites/Quartz porphyry. Water available for recharging the groundwater has become excellent in vast areas and some other areas good to poor. The groundwater table drastically goes down due to indiscriminately sinking deep bore wells and negative recharge due to scanty rain and the absence of any surface water bodies.

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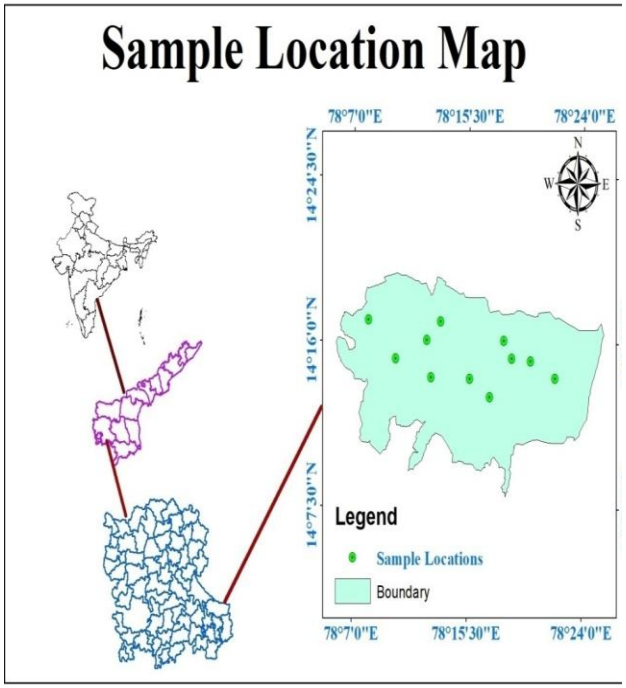

Fig.1. Location map of the Study Area

GEOLOGY:

Groundwater occurs in permeable geologic formations known as aquifers, formations having structures that allow appreciable wat er to move through them below ordinary field conditions. The portion of a rock or soil not occupied by solid mineral count may also be occupied by groundwater. These areas are recognized as voids, interstices, pores, or pore spaces. Because interstices can act as groundwater conduits they are of necessary importance to the study of groundwater. Typically, they are characterized by their size, shape, irregularity, and distribution. Original interstices created by geologic approaches governing the origin of the geologic formation and are located in sedimentary and igneous rocks. Secondary interstices developed after the rock was once formed; examples include joints, fractures, solution openings and openings formed by plant life and animals. The main rock types existing in the study are wide vary of high grade metamorphic rocks of Hornblende-Gneiss/Hornblede-Biotite Gneiss. These rocks are substantially weathered and overlain with the aid of recent fills and alluvial at places. The major rock types existing in the study area are Quartzites, grey Granite/Pink granite and Rhyolites/Quartz porphyry. The area is underlain by various geological formations ranging in age from Achaean to recent-major part of the area is underlain by the granites and gneisses and schist's of Achaean and Dharwar super group. North-eastern part of the districts is occupied by the Quartzites, limestones, and shale's of Cuddapah and Kurnool group of

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rocks.

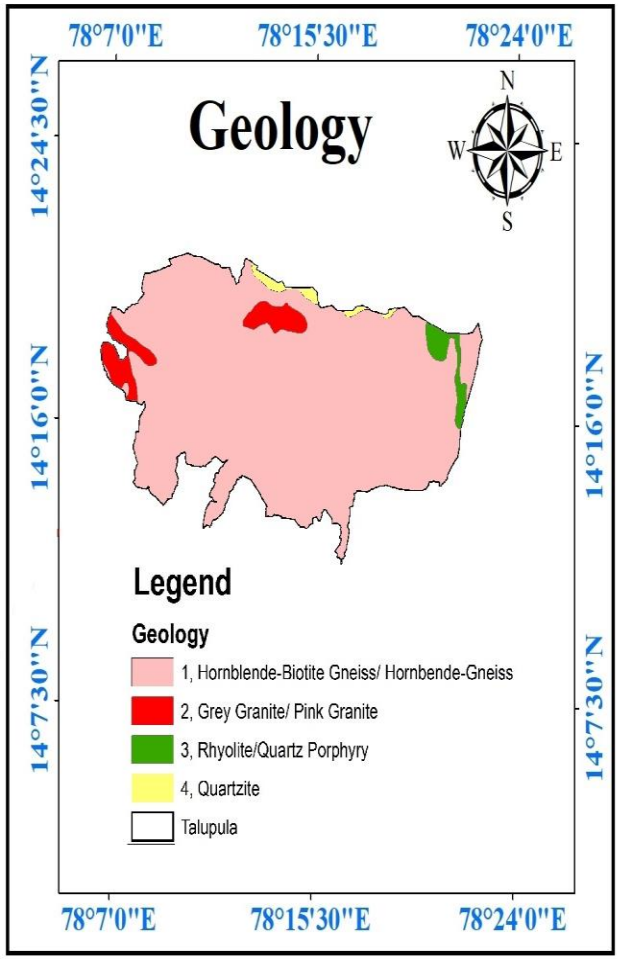

Fig.2. Geology Map of the Study Area

RESULTS AND DISCUSSION

Chemical characteristic analysis made on groundwater collected from22 locations of the study area in pre monsoon and post monsoon seasons of 2016 are given in table 1 and 2.The relation between two variables is the correlation coefficient which shows how one variable predicts the other. Associated with correlation coefficient is r, which is the percentage of variance in the dependent variable, explained by the independent variable (Arveti, N et al.,2011).The results of the correlation analysis are considered in the subsequent interpretation. A high correlation coefficient (nearly 1or -1) means good relationship between two variables and correlation coefficient around zero means no relationship. Positive values indicate a positive relationship while negative values of r indicate an inverse relationship. the correlation coefficients(r0 among various water quality parameters of groundwater of the study area in pre and post monsoon were calculated and values of colligation coefficients are given in tables 3 and 4.The results of the statistical analysis which are shown in **Table 3** (Pre-monsoon) gave an

indication that EC has a positive correlation with TDS,SO4,Na,K,Ca ,Mg and negative correlation with HCO3,Cl,F and NO3,TDS has positive correlation with HCO3,SO4,Na ,K, Ca ,Mg and TH and negative correlation with chloride, Fluoride and NO3, HCO3 has positive correlation with Chloride ,Ca ,Mg and negative correlation with SO4,Na,K,F,NO3 and TH, Chloride has positive correlation with Mg, and negative correlation withSO4,Na , K,Ca,F,NO3and TH, Sulphate has positive correlation with Na , K, Ca ,Mg and NO3 and negative correlation with F, TH, Sodium has positive correlation with K, Ca, Mg and TH and negative correlation with F, NO3, Potassium has positive correlation with Ca and F and negative correlation with Mg,NO3 and TH, Calcium has positive correlation with Mg and negative correlation with F,NO3,TH,Magnesium has negative correlation with F,NO3 and TH ,Fluoride has negative correlation with NO3 and TH, Nitrate has positive correlation with total hardness. In post monsoon seasons table 4.EC has positive significant correlation with TDS, SO4, Na, K, Ca, Mg and TH and negative correlation with HCO3, Chloride, F, NO3 and TDS has positive correlation with HCO3, SO4, Na, K, Ca, Mg and TH and negative correlation with chloride F, and nitrate.HCO3 has positive correlation with Na, K, Ca and Mg negative correlation with chloride,SO4,F,NO3,TH.Chloride has positive correlation with SO4,Mg,NO3 and negative correlation with Na, K, Ca, F, TH and Sulphate has positive correlation with Na, K, Ca, Mg and Negative correlation with F, NO3 and TH. Sodium has positive correlation with K, Ca, Mg, TH and negative correlation F, NO3. Potassium has positive correlation with Ca, Mg, TH and negative correlation with F, NO3. Calcium has positive correlation with Mg and negative correlation with F, NO3, and TH. Magnesium has no positive correlation and negative correlation with F, NO3 TH. Fluoride has negative correlation with NO3, TH. Nitrate has positive correlation with total hardness and p^H. In the study area p^H ranges from 7.10 to 8.24 with mean of 7.66 and standard deviation of 0.41 in pre monsoon season and from 7.25 to 8.28 with a mean of 7.78 and standard deviation of 0.35 in post monsoon season. The maximum permissible limit for pH in drinking water as given by the WHO is 8.5.This shows that the quality of groundwater of the study area is within the desirable limit.

Total Dissolved Solids

Concentration of total dissolved solids in groundwater decides its applicability for drinking, irrigation or containing more than 1000 mg/l of total dissolved solids is generally referred as brackish industrial purposes .The major constituents of total dissolved solids include bicarbonates, sulphates and chlorides of calcium, magnesium, sodium and silica. Groundwater water. In the study area, the total dissolved solids ranges from362.00 to 1623.00 with a mean of
856.00 mg/l and standard deviation of 398.55 mg/l in pre monsoon season and from 365.00to1675.00 mg/l with a mean of 1030.27 mg/l and standard deviation of 420.21 ^{mg}/l in the post monsoon season.

Chloride

Chloride occurs in all natural waters with varying concentration. The excessive chloride in potable water is not particularly harmful and criteria set for this ion is based on the palatability and its potentially high corrosiveness(Reddy et al., 2010).In the present study, chloride concentrations ranges from35.00 to 89.00 mg/l with a mean of 53.00 mg/l and standard deviation of 18.17 mg/l in the pre monsoon season and ranges from 40.00 to 92.00 mg/l with mean of 52.09 mg/land standard deviation of 16.17 mg/l in the post monsoon season. Almost most all samples in the study area showing below the permissible limit. Major sources of chloride in groundwater are the constituents of igneous and metamorphic rocks, like gneiss and granite etc. Because sewerage disposal and leaching of saline residues in the soil. Chlorides can only be removed by reverse osmosis process and electrolysis.

Calcium

Calcium mostly occurs in water mainly due to the presence of limestone, gypsum, dolomite and gypsyferous minerals. Permissible limit of calcium is 75 mg/l. In the present study calcium concentration ranges from 16.00to 96.00mg/l with a mean of 56.73 mg/l and standard deviation of 25.87 mg/l in pre monsoon season and ranges from 18.00 to 94.00 with a mean of 60.36mg/l and standard deviation of 25.95mg/l in the post monsoon season.

Sulphate

Sulphur in groundwater is normally present in sulphate form. Sulphate may enter into

groundwater through weathering of sulphide bearing deposits. (Rao, N.S. (2009)). Sulphate concentration above the permissible limit can cause gastro-intestinal disorders and diarrhea in human beings and desirable limit of the sulphate is200 mg/l and permissible limit is 400mg/l. in the present study sulphate ranges from 34.00 to 83.00 with a mean of 59.00mg/l and standard deviation of 15.27 mg/l in the pre-monsoon season and from 42.00 to 90.00 with a mean of 64.91 and standard deviation of 14.67 mg/l. Almost all samples in the study area below desirable limit.

Nitrate

Nitrate can reach both surface water and groundwater as a consequence of agricultural activity including excess application of inorganic nitrogenous fertilizers and manures from wastewater treatment and from oxidation of nitrogenous waste products in human and animal excreta, including septic tanks (WHO, 2011). High nitrate levels in water can cause blue baby syndrome. In the study area nitrate concentration ranges from 15.00 to 45.00 with a mean of 32.09 and standard deviation of 10.20 in pre monsoon season and ranges from 22.00 to 48.00 with a mean of 39.09 and standard deviation of 8.69 in post monsoon season. Almost all samples in the study area are below desirable limit.

Fluoride

Fluoride essential for human beings as a trace element and higher concentration of this element causes toxic effects. Due to higher concentration of fluoride in groundwater may develop molting of teeth, skeletal flourosis, deformation of in knee joints etc. The desirable limit of fluoride in drinking water is 1 mg/l and the maximum permissible limit is 1.5mg/l. The concentration fluoride in groundwater ranges from3.42 to 4.98 mg/l with a mean of 4.00 and standard deviation of 0.45 mg/l in the pre monsoon season and ranges from3.20 to 4.85 mg/l with a mean of 3.96 mg/l and standard deviation of 0.44mg/l in post monsoon season .Almost all samples in the study are above the permissible limit.

Fluoride sources and geological influence

Fluoride incidence in groundwater is mainly a natural phenomenon, influenced basically by the local regional geological settings and granite gneiss commonly contains fluorine bearing minerals. The important fluorine

bearing minerals are fluorite, apatite, certain amphiboles and micas. The solubility constant of barium fluoride BaF2 is $1.84x10^{-7}$.The solubility constant of fluoride in pure water at 25ºC is $3.45x10^{-11}$. Magnesium fluoride solubility constant value is $5.16x10^{-11}$ is more soluble than calcium fluoride; sodium fluoride is very soluble. (Rao, N.S. 2008). In the study area the concentration of fluoride in the ground water in the groundwater vary from 3.42 to 4.98 mg/l l in the pre monsoon season and ranges from3.20 to 4.85 mg/l in post monsoon season. In the study area granites granite gneiss commonly contains fluorine bearing minerals. High weathering rates and enhanced circulation of water in the weathered rocks due to intensive and long time irrigation are responsible for the leaching of fluoride from their parent minerals present in soils and rocks. Further concentration has been brought about due to the arid climate of the region and residence time of ground water in the aquifer. Under the conditions of the arid climate, the action of evaporation and concentration is strengthened. In the conditions of the semi-arid climate movement of groundwater is slow and distribution areas of weathering crust of granite and alkaline magmatic rock and area of soda Stalinized soil are advantageous to the concentration of fluoride in groundwater.

Conclusion

The study area reveals that all pH samples are within the desirable limit. In the study area, the total dissolved solids ranges from362.00 to 1623.00 mg/l in pre monsoon season and from 365.00to1675.00 mg/l in the post monsoon season. Out of 22 samples+11 pre-monsoon +11 post monsoon] two samples in the pre-monsoon and one sample in post-monsoon are below the desirable limit, remaining samples are above the permissible limit. Nitrate concentration ranges from 15.00 to 45.00 mg/l in pre monsoon season and ranges from 22.00 to 48.00 mg/l in post monsoon season. Almost all samples in the study area are below desirable limit.

The concentration fluoride in ground water ranges from3.42 to 4.98 mg/l in the pre monsoon season and ranges from3.20 to 4.85 mg/l in post monsoon season .Almost all samples in the study are above the permissible limit. In the study area granites, granite gneiss commonly contains fluorine bearing minerals. High weathering rates and enhanced circulation of water in the weathered rocks due to intensive and long

time irrigation are responsible for the leaching of fluoride from their parent minerals present in soils and rocks. Fluoride has negative correlation with NO3 and TH.

Table.1 Chemical characteristics of Ground Water [Pre –Monsoon]

Name of the village	pH	E.C	T.D.S	HCO3	CL	SULPHATES	Na	K	Ca	Mg	F	No_3	Total hardness
Peddanavari palle	7.91	1275	816	160	76	56	104	5	40	112	3.70	40	619
Gajjallapagari palle	7.25	1896	1213	260	40	83	150	9	96	92	4.10	20	139
Talupula	8.15	565	362	180	40	48	74	8	16	24	4.98	45	561
Vepamanipeta	8.24	780	620	350	89	62	114	10	45	86	3.80	38	438
Gundhuvari palle	7.92	850	554	450	50	40	117	9	44	83	4.20	35	330
Ganjhivari palle	7.78	554	567	735	75	34	66	8	58	87	3.90	15	448
Maduguthanda	7.23	2536	1623	250	45	80	130	8	40	112	3.50	40	580
Kurlli	7.10	1900	1216	350	48	68	180	10	88	92	4.40	20	366
Udumulakurthy	7.83	760	490	650	45	62	160	5	82	95	3.75	25	438
Batraypalle	7.71	11.69	750	420	35	51	140	9	35	60	4.2	35	520
Turakavandlapalle	7.13	1890	1205	340	40	65	215	10	80	90	3.42	40	720
Minimum	7.10	11.69	362	160	35	34	66	5	16	24	3.42	15	139.00
Maximum	8.24	2536	1623	735	89	83	215	10	96	112	4.98	45	720.00
Average	7.66	1183.43	856	376.82	53	59	131.82	8.27	56.73	84.82	4	32.09	469.00
Standard Deviation	0.41	772.21	398.55	181.22	18.17	15.27	44.07	1.79	25.87	24.57	0.45	10.2	158.14

Table.2 Chemical Characteristics of Ground Water [Post –Monsoon]

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Name of the village	pH	E.C	T.D.S	HCO3	CL	SULPHATE	Na	K	Ca	Mg	F	No_3	Total hardness
Peddanavari palle	7.95	1282	820	165	78	60	106	8	42	118	3.72	42	633
Gajjallapagari palle	7.28	1899	1218	264	42	85	156	9	94	98	4.2	22	142
Talupula	8.20	570	365	184	45	51	76	8	18	27	4.85	48	570
Vepamanipeta	8.28	785	628	355	92	65	115	9	46	90	3.7	40	440
Gundhuvari palle	7.92	855	560	448	48	42	120	8	50	85	4.2	38	350
Ganjhivari palle	7.35	2630	1675	270	55	90	140	8	42	120	3.9	45	600
Maduguthanda	7.80	2010	1235	380	50	75	210	12	90	98	4.4	25	410
Kurlli	7.9	780	1510	680	52	68	180	8	89	100	3.9	35	450
Udumulakurthy	7.25	1899	1320	380	48	70	225	12	90	100	3.6	48	780
Batraypall	7.85	1150	1210	350	45	55	150	9	58	68	3.9	45	810
Turakavandlapalle	7.8	1178	792	452	40	53	162	9	45	65	3.2	42	510
Minimum	7.25	570	365	165	40	42	76	8	18	27	3.2	22	142
Maximum	8.28	2630	1675	680	92	90	225	12	94	120	4.85	48	810
Average	7.78	1367.09	1030.27	357.09	54.09	64.91	149.09	9.09	60.36	88.09	3.96	39.09	517.73
Standard Deviation	0.35	651.56	420.21	143.44	16.17	14.67	44.65	1.51	25.95	26.60	0.44	8.69	191.99

Table.3 .Correlation matrices of Ground water [Pre-Monsoon]

pH	E.C	T.D.S	HCO3	CL	So4	Na	K	Ca	Mg	F	No3	TH
E.C	1.00											
T.D.S	0.90	1.00										
HCO3	-0.43	0.90	1.00									
CL	-0.18	-0.29	0.14	1.00								
So4	0.78	0.78	-0.47	-0.29	1.00							

Na	0.50	0.56	-0.06	-0.48	0.59	1.00						
k	0.16	0.30	-0.11	-0.13	0.12	0.30	1.00					
Ca	0.45	0.39	0.28	-0.18	0.49	0.69	0.14	1.00				
Mg	0.60	0.56	0.08	0.33	0.44	0.33	-0.24	0.47	1.00			
F	-0.41	-0.44	-0.17	-0.28	-0.32	-0.37	0.17	-0.30	-0.81	1.00		
No3	-0.02	-0.04	-0.63	-0.06	0.00	-0.07	-0.03	-0.69	-0.27	-0.02	1.00	
TH	0.00	0.04	-0.19	-0.04	-0.16	0.05	-0.19	-0.45	-0.04	-0.33	0.66	1.00

Table.4 .Correlation matrices of Ground Water [Post-Monsoon]

pH	**E.C**	**T.D.S**	**HCO3**	**CL**	**So4**	**Na**	**k**	**Ca**	**Mg**	**F**	**No3**	**TH**
E.C	1.00											
T.D.S	0.71	1.00										
HCO3	-0.25	0.71	1.00									
CL	-0.18	-0.22	-0.21	1.00								
So4	0.81	0.76	-0.12	0.05	1.00							
Na	0.51	0.68	0.51	-0.35	0.42	1.00						
k	0.43	0.27	0.08	-0.16	0.27	0.79	1.00					
Ca	0.39	0.63	0.47	-0.26	0.49	0.85	0.61	1.00				
Mg	0.62	0.63	0.08	0.38	0.63	0.38	0.14	0.46	1.00			
F	-0.11	-0.22	-0.30	-0.23	-0.02	-0.32	-0.08	-0.09	-0.38	1.00		
No3	-0.22	-0.21	-0.19	0.11	-0.40	-0.31	-0.21	-0.64	-0.30	-0.25	1.00	
TH	0.03	0.14	-0.14	-0.05	-0.20	0.08	0.15	-0.27	-0.10	-0.29	0.82	1.00

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