International Journal of Engineering & Scientific Research
Vol. 10 Issue 8, August 2022,
ISSN: 2347-6532 Impact Factor: 6.660
Journal Homepage: http://esrjournal.com, Email: esrjeditor@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

HYDROGEOCHEMICAL EVALUATION OF FLUORIDE CONTAMINATION IN GROUNDWATER OF SIMALDHAB VILLAGE, BARHAIT, SAHIBGANJ, JHARKHAND

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ABSTRACT

Groundwater is one of the most important natural resource for our day to day life. In the present paper, the authors intense to evaluate the groundwater quality of the village simaldhab and adjoining villages in Barhait Block of Sahibganj Jharkhand. The present study has been initiated in order to have thorough scientific study of groundwater contamination level there probable causes and remedial measures. The area under study is situated on Rajmahal traps which is composed primarily of Tholeiitic basalt which intertrappean beds. The dugwell and few number of tubewells are only source of water for the inhabitant. A systematic monitoring of groundwater quality when subjected to statistical analysis certain conclusion can be drawn such as majority of water samples is of Ca-Na-Hco_3 type. Out of 13 samples 7 samples were found to have very high fluoride concentration leading to Dental fluorosis, skeletal fluorosis and bone deformation in the inhabitant of the area.

Keywords Hydrogeochemistry, Rajmahal traps, Thoellitic basalt , Fluorosis

INTRODUCTION

Sahibganj is one of 24 districts in the state of Jharkhand, India which came into existence in 1983. The district is having a total area of about 4.25 km2 which comprises of hills and ranges of Rajmahal hills and contains forest all over the ranges called Damin-i-koh. It is the most north eastern part of Jharkhand and is bounded on North by river Ganga and Katihar district, Bihar and Godda district on South, Maldhaand Murshidabad district of West Bengal on East and Bhagalpur and Godda in the West. It lies approximately between 24°42' N and 25°21' N Latitude and between 87o25' E⁰ and 87o54' E Longitude with average elevation of 16 m. Berhait is one of the nine blocks of Sahibganj district which, in turn, is located in the north east extremity of the state to the south of river Ganga. The entire district is located on Rajmahal traps / Rajmahal formation which is composed primarily of tholeiitic basalt with lateritic rocks & lateritic alluvium. The district as a whole has an average elevation of 16 m from the mean sea level. The major River flowing through the district are Ganga, Gumani, Morang &Bansloi. The river Ganga forms the northern boundary of the district

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The drainage of the entire district and that of Berhait block in particular is of dendritic type, Ganga and Gumani are the two perennial rivers, the river Ganga is flowing at the foothills therefore, it is difficult for the inhabitants to use the water of River Ganga for their domestic and agricultural pursuits due to the fact that they are residing at a greater elevation. As the remaining River systems are seasonal in nature therefore, majority of the population except Sahibganj&Rajmahal township is heavily dependent on underground water sources. For meeting their domestic & agricultural needs the occurrences & exploitation in entire area is a big problem due to hard rock terrain.

The area selected for the present study, Simaldhab village is located some 7 km south west of Berhait township. The village having more than 2000 population lies between latitudes $24.8847°N$ to $24.9069°N$ and longitudes $87.5560°E$ to $87.5649°E$ covering about 5.16sq.km. The village Simaldhab isbounded by Dudhiapokhend and Ranga from the North direction, Kundli and Raksi from east with Gopaldih sharing the boundary with the village as the river Morang makes the outer boundary in S-E direction. Jhabri and Labri making the boundary from the South and the village shares its boundary with Dharampur and Dugubathan in the west.

THE STUDY AREA

***Fig. 1.1** Base map of Simaldhab , Berhait , Sahibganj , Jharkhand*

Water is a renewable natural resource of the earth and due to weathering of parent rocks and anthropogenic activities its quality depends on the physical and chemical constituents which present in it. Hence, hydrogeochemistry becomes an important factor in determining the suitability of groundwater for consumption and other purposes like irrigation and industries (Goyal et.al.,2010, Todd 1980) where the hydrogeochemistry of water depends on factors like geological setting, flow of water through soil and cracks, climatic changes, aquifer materials and additions during percolation of water (Laurent et. al., 2010). Due to the dependence of water on several factors there cannot be any straight forward reasons for its deteriorating quality (Jothivenkatchalam et. al., 2010) and this is why concern for protection and management of ground water quality is needed. The area under investigation had low quality water due to its geological properties like presence of lateritic alluvium and some other pollutants available in the area (natural or non-natural). The low-quality water, especially higher fluoride concentration was observed due to 2 rhyolitic flows near the study area were reported (R.W Rent et. Al) and even water was not clear. Water quality parameters cannot be easily determined as it requires regular inspection due to the changing nature of water in its quality seasonally. So a methodology using mathematical relationship for comparison of physicochemical parameters was adopted (Sarkar et. Al., 2006). The area selected for investigation as it was observed that some life-threatening problems of fluorosis was anticipated and some local newspaper highlighted the problem. Due to the complex geological setting and diversified anthropogenic reasons the entire district of sahebganj has been the centre of attraction for the researchers working on quality of groundwater. In Sahibganj, the rainfall is generally contributed by the South-west Monsoon which sets in the mid-June till September. The normal average rainfall is about 1500mm in the district. The climate here is humid to sub-humid, the summer comes here in March and lasts till mid-June. The winter, here prevails from mid-November till last February. The maximum temperature in the district marks to $44°C$ in March-May time. The minimum temperature of the district goes below to 6.8^{o}C with December being the coldest month of the year.

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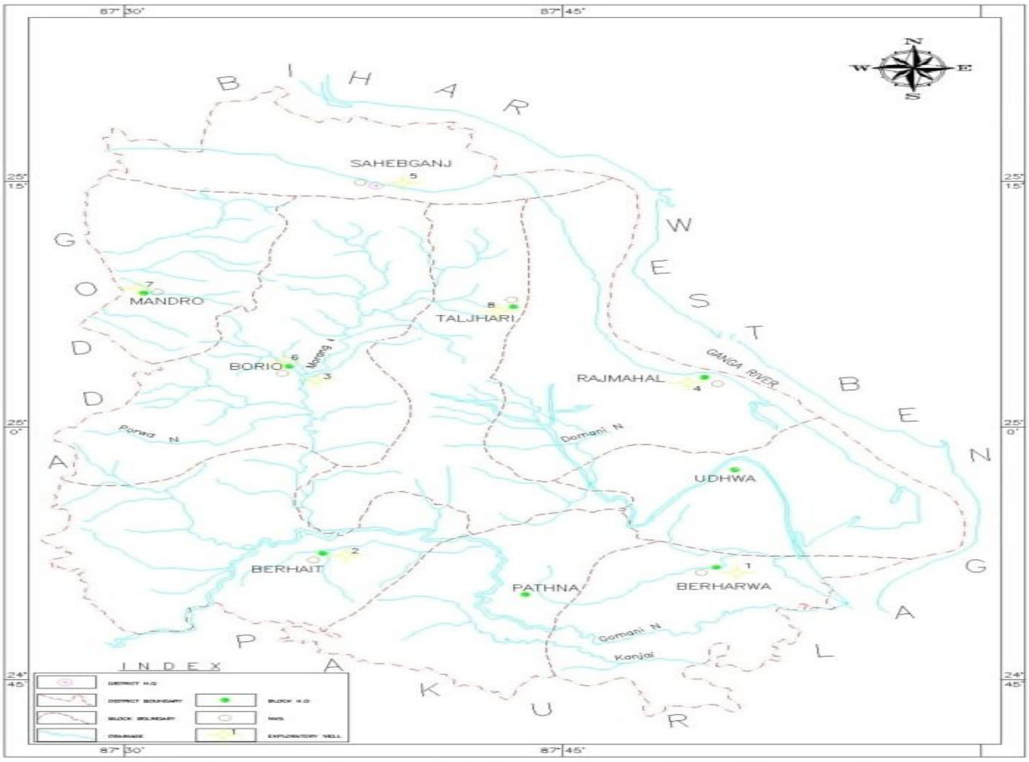

Fig.2.1. Drainage Pattern of Sahibganj, Jharkhand, Source ***CGWB***

Geology of the Study area

Geologically, the district as a whole consists of tholeiitic basalt capped by lateritic rocks and lateritic alluvium. The entire district is composed of five different types of rock assimilates. A group of hard crystalline rocks of Precambrian age forms the basement of the entire area which is often designated as Chota Nagpur granite gneiss and is the oldest formation of the area. These Precambrian are actually metamorphic and are primarily composed of quartz, mica cite and granite gneiss. The Precambrian are overlain by the Gondwana supergroup of rocks. The Gondwana are composed of Talchir formation, Braker formation and Dubrajpur formation of these three litho-units the Dubrajpur formation is the most develop litho-unit and is designated as the storehouse of floral assimilates the Barakar formation is the intermediate layer composed of alternating layers of Sandstone, Shale and Coal deposits. After the formation of Gondwana super group there was a period of non-deposition. The rocks of Gondwana super group are succeeded by Rajmahal basalt which are collectively known as Rajmahal traps. The Rajmahal traps are composed of nine basaltic lava-flows which varying in thickness from 60ft to 300ft. These flows are laid down one above another with intertrappean beds which are in fact bentonitic or tuffaceous in nature and do

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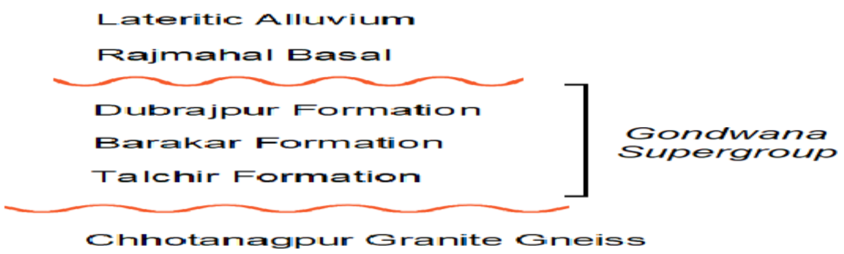
contain a lot of plant fossil cum of which are index fossil such as Ptilophyllum Vertebrae & William Sonia. All the flows are essentially of basaltic composition & are made up of augite, labradorite, pigeonite, opaques. Among the secondary minerals palagonite, secondary silica, calcite & zeolite is the most important minerals. At places some blanket bauxite deposits are also found. What is significant is that the primary basaltic rocks are changed to laterite and finally bauxite due to the residual concentration processes. The by-product of these process is the formation of bentonite and kaolinite. The world-famous China clay deposits of Rajmahal are a good example. The primary basaltic rocks are not considered to be as good aquifers. Whatever water is available below the surface of the earth is stored in the joints, cracks and fissures. The Rajmahal traps is also facing a problem of injudicious mining, development and erection of illegal stone crushers which is responsible for imbalance in the underground water system of the area. On the basis of the petrology and petrography of the Sahibganj district as a whole and the area under investigation in particular, a generalised succession can be summarised as given



Succession of Rajmahal Hills

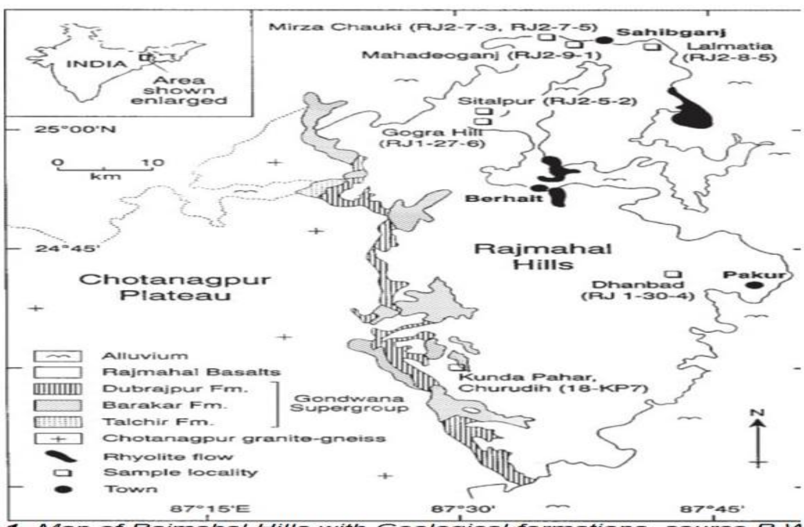


Fig.3.1. Map of Rajmahal Hills with Geological formations, source R.W. Rent et al

Material & Methods

Altogether 13 samples were collected from different sampling sites out of which 3 are of hand pumps (HP) and 10 are from dug well (DW). Area under investigation was physically surveyed and sampling sites were selected. The area selected for the study is geologically composed of a narrow strip of Gondwana rocks. The inhabitants of the area are dependent on hand pumps, dug well water, pond water, river water for their drinking water purpose as well as their domestic uses. Hence, for comprehensive hydrogeochemical study water samples have been collected from all sources of water. The samples were collected from the tube wells after pumping out water for about 10 min to remove stagnant water from wells. The chemical analysis is based on Techniques of Water Resources Investigation of U.S.G.S. Book 5, Chapter A-1 (1979), (b) Standard Method for examination of the water and waste-water prepared by American Public Health Association (1976) and (c) Indian Standard Methods of Sampling and Test (Physical and Chemical) for water IS-3025. The relevant information such as GPS location of sampling site, depth of water as and when required, temperature of water sample, colour and odour of sample collected is recorded at the very time of sampling, Water analyser S.371, Systronics was used for determining Temperature, odour, colour, Ph, TDS and conductivity in the field area and also was analysed in the laboratory for ion chemistry by following the procedures of standard method as described in APHA. All the volumetric glassware, such as pipette, burettes, flasks were washed with washing liquid and tap water. After that they were rinsed with 1.4 HNO3, and then rinsed twice distilled water. Three different analytical procedures have been adopted for the present work. They are titrimetric analysis, spectrophotometric and atomic absorption spectrophotometry. By titration method Ca and Mg were determined. Chloride was determined by standard AgNO3 titration. Na & K were determined by Flame photometry. Sulphate and Nitrate were determined by UV Spectrophotometer (UV 3200 lab India) and Fluoride was analyzed by colorimetric method. The Fluorid3 concentration was cross checked on ion chromatograph to ascertain the Fluoride concentration in samples.

RESUTS AND DISCUSSION

The chemical composition of the Groundwater depends on the chemical composition of rocks through which water passes (Hem, 1970). The chemical composition of the groundwater in the area under study shows different trend and gradient in relation to bed rock geology. The area under study is a part of Rajmahal traps which is composed primarily of tholeiitic basalt overlaid by lateritic alluvium. To rhyolitic flows have also been reported in the area (Kent et. al. 2006). The area under basaltic cover is characterized by interconnected joints, fissures and fractures. These structural features are in fact the only favorable sites for occurrences of groundwater. Groundwater occurs under phreatic condition in the weathered mantle and under semi-confined condition in the joints and fractures. Big diameter dug wells are more produced in the area. Due the fact that recharged tube wells are dependent upon infiltration of water through joint, cracks and fissures. During the

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visit of the area, it was observed that the deep dug wells were found to be more perennial in nature whereas the shallow dug wells becomes dry in the summer season. The quality of ground water depends upon the processes and reactions which acted on water from moment of its condensation in the atmosphere to the time of discharge. For the proper understanding of the geochemical evolution of Groundwater, its classification is must. In the present work, the concentration of major ions, as required have been used to plot a piper-trilinear diagram which reveals that the majority of water is of Ca-Na-HCO3 type and two samples were found to be Ca-Mg-Cl type.All the parameter selected for the study were well within the permissible limit as prescribed by WHO drinking water standards and BIS drinking water standards except fluoride, But, what is significant isthat, total dissolved solid Mg2+, Ca2+ and NO3- were found to be higher than desirable limits as prescribed by WHO

Parameters	*No. of Samples*	*Min. Value*	*Max. Value*	*Mean*	*Median*	*Std. deviation*	*WHO stds.*		*BIS stds.*	
							Desirable	Permissible	Desirable	Permissible
pH	13	6.43	8.4	7.07923	6.8	0.6405	7.0-8.0	6.4-9.2	6.5-8.5	6.5-9.2
EC	13	400	755	577.308	600	106.783	750	1500	-	-
TDS	13	390	1070	690	680	215.561	500	1500	500	2000
Sodium (Na^+)	13	121.6	713	334.831	336.9	172.507	50	200	-	-
Potassium (K^+)	13	9.7	28.3	13.5231	12.9	4.6537	10	12	-	-
Magnesium (Mg^{2+})	13	1.5	28.7	10.7846	8.5	8.48586	30	100	30	100
Calcium (Ca^{2+})	13	11.2	156.6	48.9462	24.8	45.5931	75	200	75	200
Fluoride (F^-)	13	0.5	17.3	5.08308	1.58	6.2393	1	1.5	1	1.5
Chloride (Cl^-)	13	39.1	395.3	168.692	132	126.434	250	600	250	1000
Total Alkalinity	13	87.6	478	295	343.8	111.815	300	600	200	600
Sulphate (SO_4^{2-})	13	19.3	196.9	69.4846	48.4	56.973	200	600	200	400
Nitrate (NO_3^-)	13	29.1	314.1	88.3615	52.4	82.763	50	-	45	-
Phosphate (PO_4^-)	13	1	6.5	3.5769	3.9	1.995	0.1	1	-	-

Table 6.3. Statistical analysis of water quality parameters(data) of the pre-monsoon samples with Prescribed WHO standards (1997) and BIS standards (IS-10500) 1991.

	pH	EC	TDS	Na^+	K^+	Mg^{2+}	Ca^{2+}	F^-	Cl^-	HCO^{3-}	SO_4^{2-}	NO_3^-	PO_4^{2-}
pH	1												
EC	-0.22	1											
TDS	-0.61	0.81	1										
Na^+	0.02	0.84	0.58	1									
K^+	0.42	-0.34	-0.32	0.01	1								
Mg^+	-0.71	0.29	0.77	0.08	-0.18	1							
Ca^{2+}	-0.56	0.34	0.77	0.23	-0.05	0.92	1						
F^-	0.91	0.08	-0.33	0.31	0.39	-0.62	-0.38	1					
Cl	-0.29	0.58	0.77	0.54	-0.22	0.67	0.8	-0.06	1				
HCO^{3-}	-0.42	-0.2	0.04	-0.55	-0.43	0.28	-0.01	-0.64	-0.09	1			
SO_4^{2-}	-0.4	0.56	0.8	0.47	-0.2	0.8	0.88	-0.18	0.89	-0.14	1		
NO_3^-	-0.49	0.39	0.75	0.23	-0.12	0.93	0.91	-0.39	0.68	0.05	0.88	1	
PO_4^{2-}	-0.19	0.3	0.46	0.13	-0.31	0.35	0.34	-0.03	0.53	0.26	0.45	0.29	1

Table 6.4. *Correlation coefficient matrix of pre-monsoon data*

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Hydrogen ion concentration (pH)

The result of the chemical analysis indicates that the mean pH value is 7.079 and standard deviation is 0.6405 during pre-monsoon season with minimum value of 6.43 and maximum value 8.4.

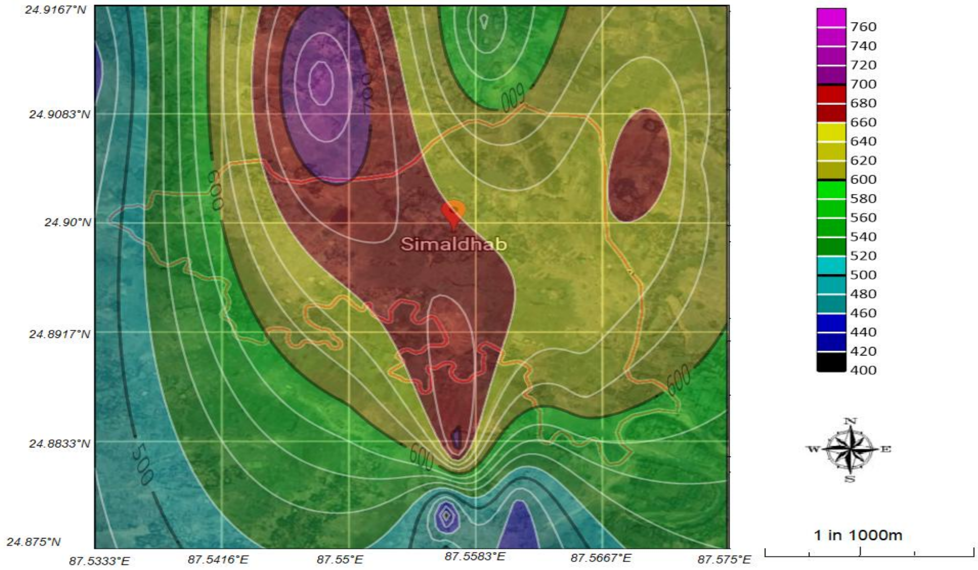

Fig.6.1. *Pre-monsoon pH Contour over Base Map*

Specific Electrical Conductivity

The temperature change has a very significant impact on conductivity and resistivity. The conductance increases by 2% with an increase in temperature of every 10°C. The standard temperature to measure conductivity is normally taken as 250°C.The specific electrical conductance ranges between 400µS/cm to 755µS/cm with an average value of 577.3µS/cm in the study area during pre-monsoon season.

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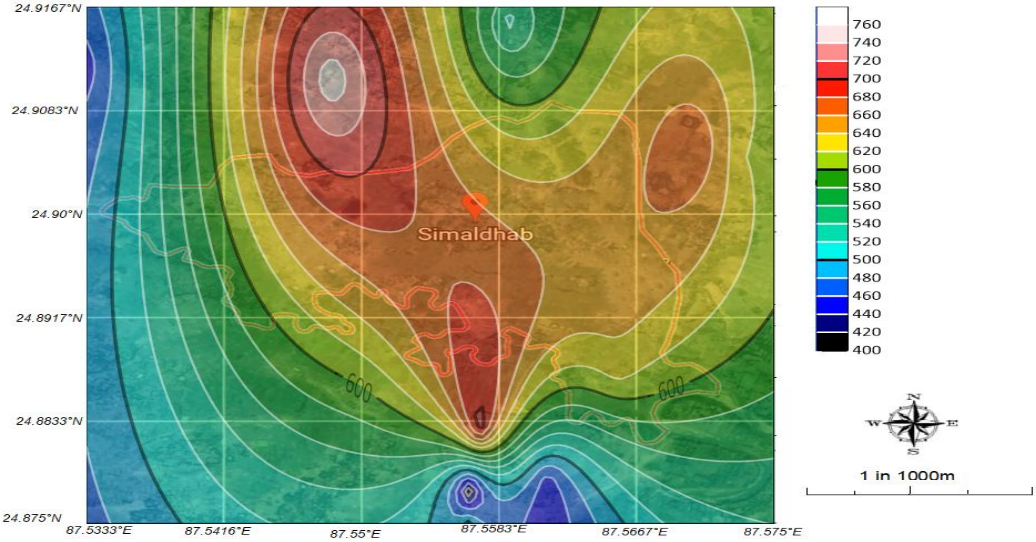


Fig.6.2. *Pre-Monsoon Electrical Conductivity contour over base map*

Total Dissolved Solids

The range of TDS concern in the study area varies from the minimum value of 390ppm to maximum of 1070ppm with an average of 690ppm in pre monsoon water samples. There is a strong Correlation between TDS and specific electrical conductivity in the area. It shows a distinct linear relationship between specific conductivity and TDS of water samples collected from different sampling sitesFrom the observation and analysis of water samples , it can be concluded that the water present in the area is having total dissolved solids (TDS) more than desirable limits of BIS and WHO and the water quality is not up to the mark. The strong correlation between the TDS and conductivity is shown in graph.

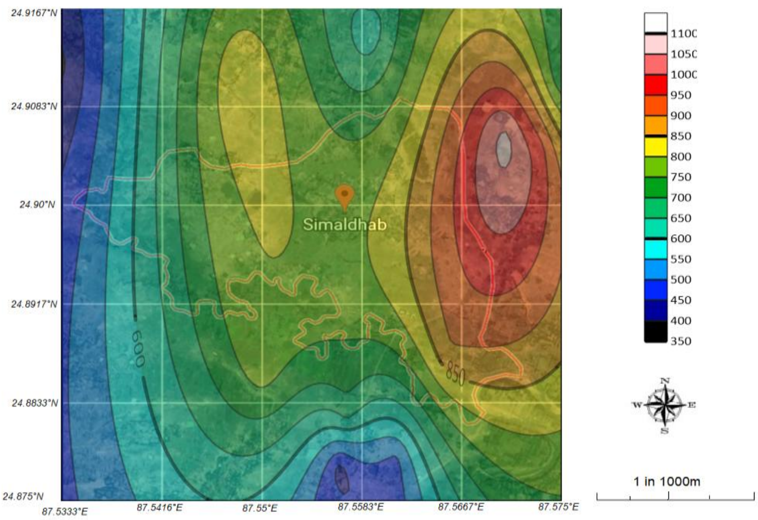
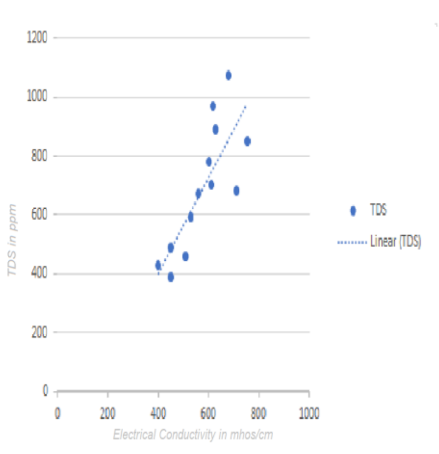


Fig.6.3. *Pre-Monsoon TDS contour over Base Map*



Graph.6.1. *Scattered trendline diagram of EC vs TDS*

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Calcium

The Major constituent of igneous, sedimentary and metamorphic rocks is Calcium, The silicate minerals are not soluble in water directly, rather its breaks down the minerals into soluble calcium products and clay minerals. However, the calcium of sulphate and carbonate are soluble in water. Owing to the fact that Calcium is found everywhere either in groundwater or most of the rocks

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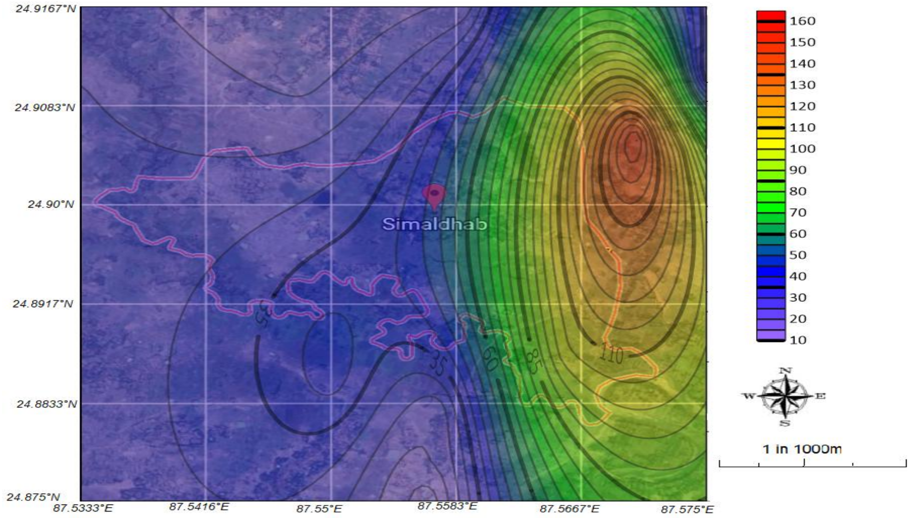

Fig.6.4. *Pre-Monsoon Calcium Contour over Base Map*

It clearly shows that high Ca2+ concentration present in the northern area (Archaean terrain) of the study area during pre-monsoon season in contour maps. A comparatively low Ca2+ concentration in the southern area (Gondwana area) may be due to the area which is composed of ferruginous sandstones, carbonaceous shale and coal seams. In pre-monsoon, the range of calcium concentration in water samples varied from 11.2mg/l to 156.6mg/l with an average of 48.94mg/l .

Magnesium

The Mg^{2+} in groundwater of the study area varies from 1.5ppm to 28.7ppm with an average value of 10.78ppm in pre-monsoon season. The spatial distribution of Mg^{2+} in the study area is shown in fig.6.5 for pre-monsoon

It is being shown a poorly positive correlation between Mg^{2+} and Ca^{2+} in the Pearson correlation matrix in the sampled water of the area.

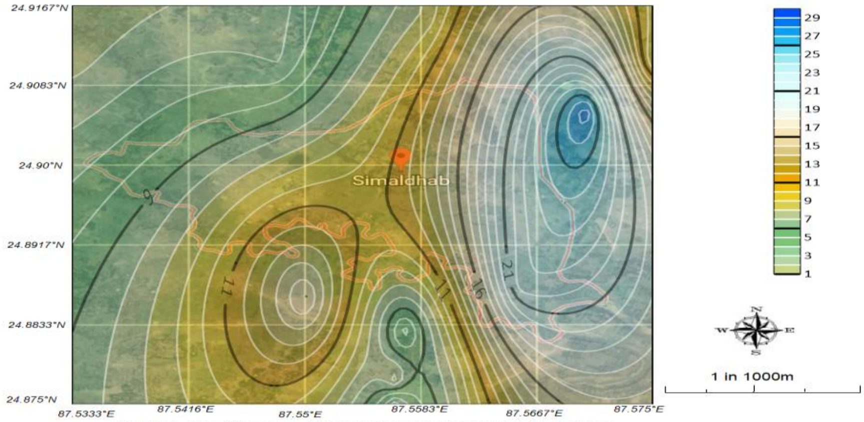

Fig.6.5. Pre-Monsoon Magnesium Contour over Base Map

Sodium

Geogenic sources of sodium is added in groundwater, the industrial and domestic wastes also added up in its concentration. When sodium is excess of 250mg/l in drinking water, it may cause cardiovascular and nephrological problems in human beings.

So far as the concentration of Na^+ in the area of under study is concerned the mean value is 334.831mg/l with no sample having less than the desirable limit, during the pre-monsoon season

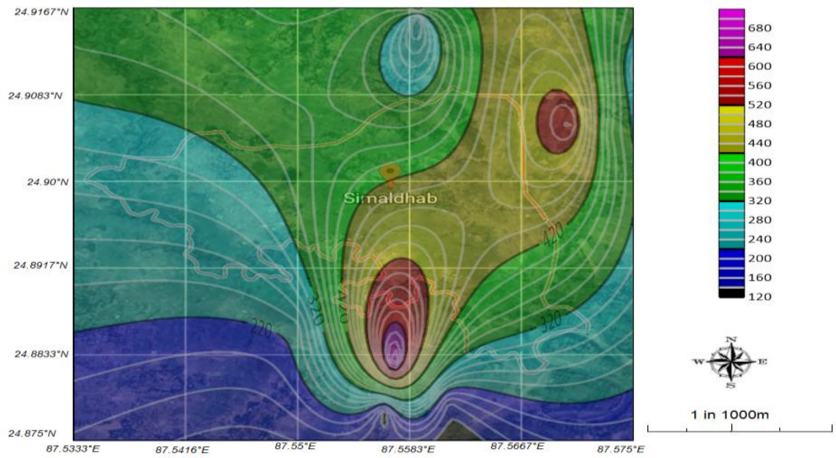

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Fig.6.6. Pre-Monsoon Sodium Contour over Base Map

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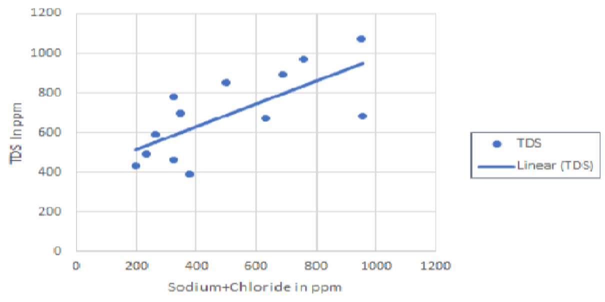
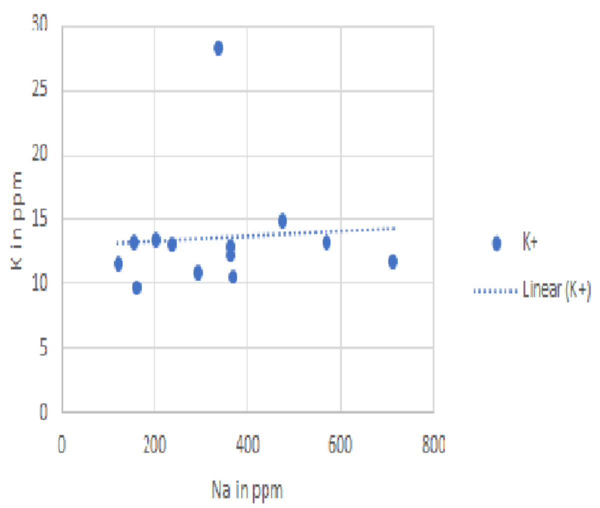


Graph.6.2. *Scatter trendine diagram TDS vs Sodium+Chloride*

Potassium

The range of potassium concentration in pre monsoon water samples varied from a minimum value of 9.7ppm to a maximum of 28.3ppm with an average value 13.52ppm. The spatial distribution of the potassium is shown in fig.6.7 and the correlation of Sodium and potassium is shown in graph 6.3



Graph.6.3. *K scatter trend with Na*

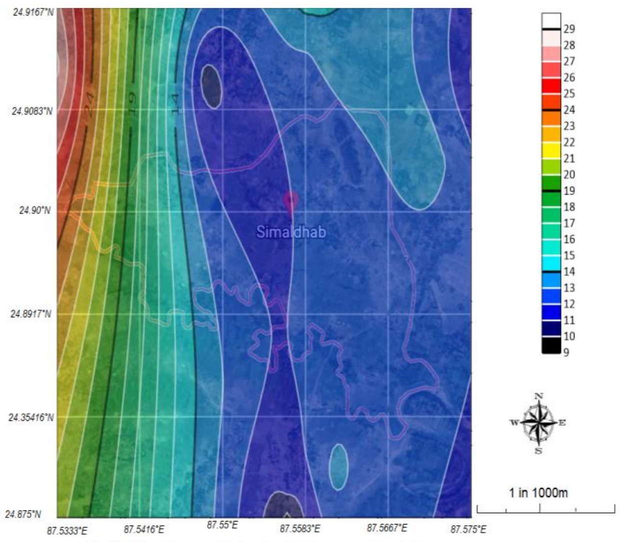


Fig.6.7. *Pre-Monsoon Potassium Contour over Base Map*

Total Alkalinity (Bicarbonate and Carbonate)

The Ph of water indicates, weather alkalinity is in carbonate or bicarbonate form. When pH is less than 4.5 presence of carbonic acid is indicated, when pH is less than 4.5 bicarbonate is indicated and when pH is in between 4.5 and 8.2 carbonate is indicated. The pH in the study area is above 4.5 and below 8.2, hence there is only bicarbonate alkalinity and no carbonate alkalinity. The value of alkalinity in the study area varies from minimum value of 87.6ppm to the maximum of

478ppm with an average of 295ppm in the pre monsoon sample.

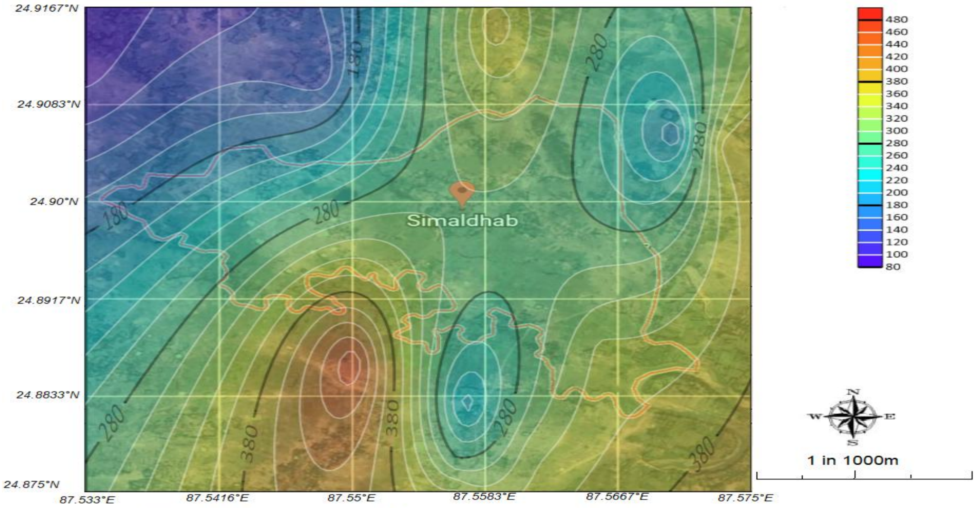


Fig.6.8. Pre-Monsoon Alkalinity contour over Base Map

Chloride

Chloride in groundwater is largely derived from cyclic salts, which are carried by different natural factors such as clouds and precipitated on the land surface as rain or snow.

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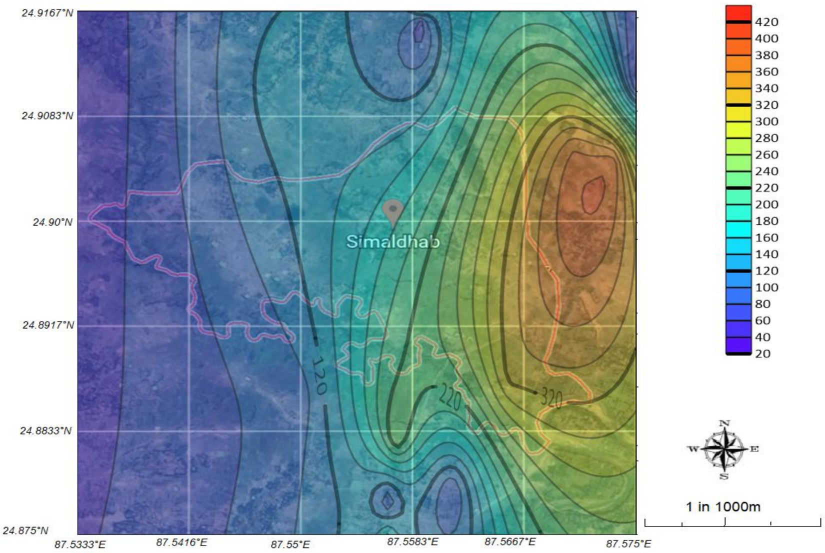
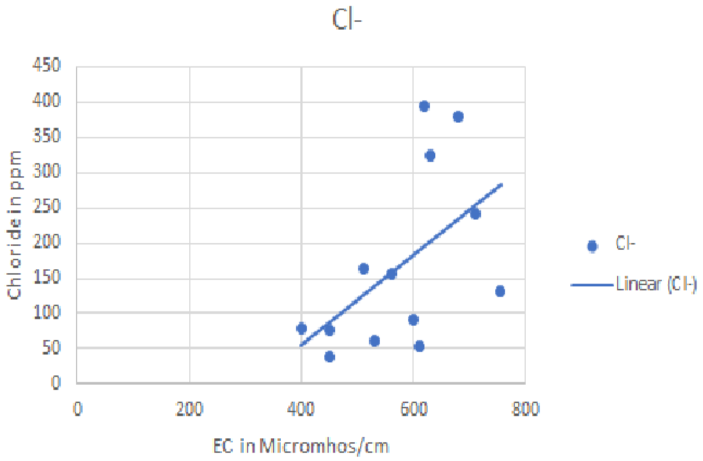
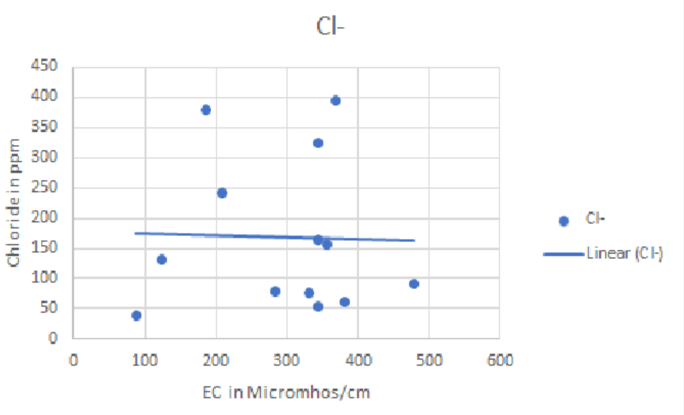


Fig.6.9. *Pre-Monsoon Chloride Contour over Base Map*



Graph.6.4. *Point scatter trendline of chloride vs EC*



Graph.6.5. *Point scatter plot of Chloride vs alkalinity*

Sulphate

International Journal of Engineering & Scientific Research
Vol. 10 Issue 8, August 2022,
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The range of concentration of sulphate in study area is about 19.3ppm to 196.9ppm in pre-monsoon samples. The spatial distribution of sulphate during pre-monsoon water samples of the area is shown in fig.The sulphate contour map for pre-monsoon period clearly indicates that high value of sulphate present in Archean area as compared to the coal bearing Gondwana area. It shows good correlation with sp. Conductivity and chloride in the ground water of the area (Karanth,1972). The point scatter trendline of sulphate with sp. Conductivity and chloride is shown in graph

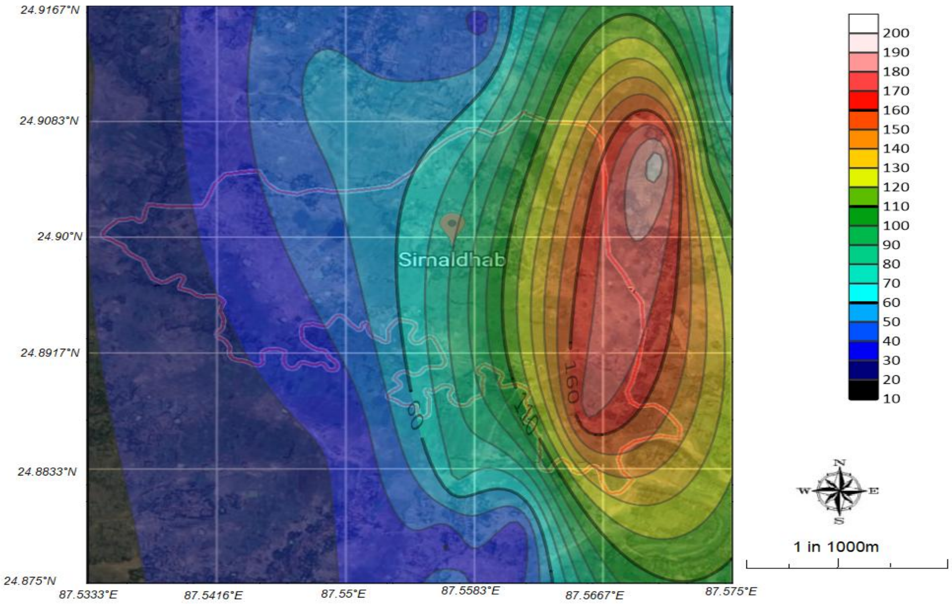
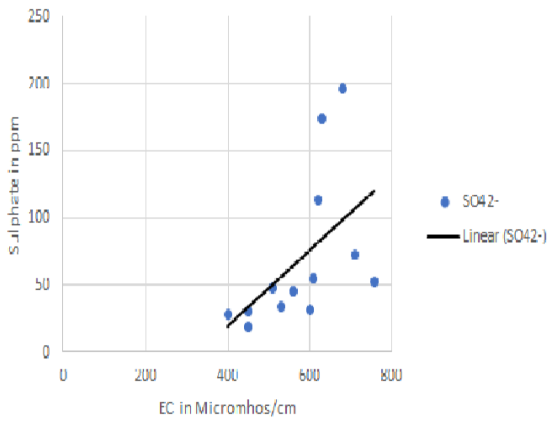
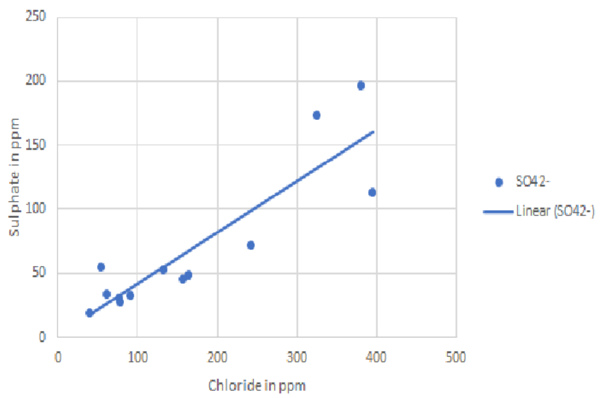


Fig.6.10. *Pre-Monsoon Sulphate contour over Base Map*



Graph.6.6. *Relationship between Sulphate and EC*



Graph.6.7. *Relationship of Sulphate vs chloride*

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Nitrate

The concentration of nitrate in groundwater when it is not polluted is less than 5ppm, but polluted water contains up to 100ppm or more. The nitrate polluted water indicates possibility of presence of pathogenic bacteria in it. Water with 45 ppm is harmful for infants and if the concentration of nitrate present in high level can cause cyanosis and death.Concentration of nitrate in the groundwater sample of the study area lies in the range of 29.1 to 314.1mg/l with an average of 88.36mg/l in the pre monsoon season.

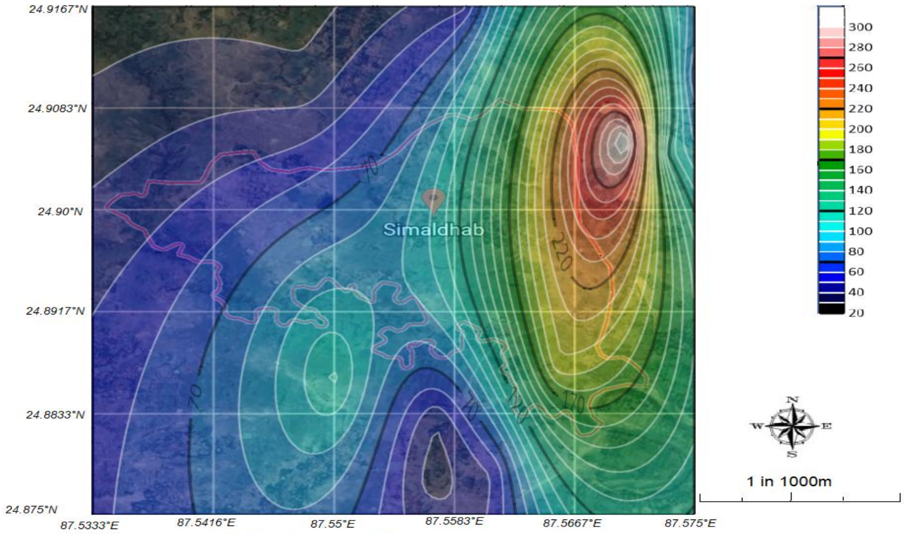

Fig.6.11. *Pre-Monsoon Nitrate contour over Base Map*

Phosphate

Phosphates are not toxic to people or animals unless they are present in very high levels. Digestive problems could occur from extremely high levels of phosphates.

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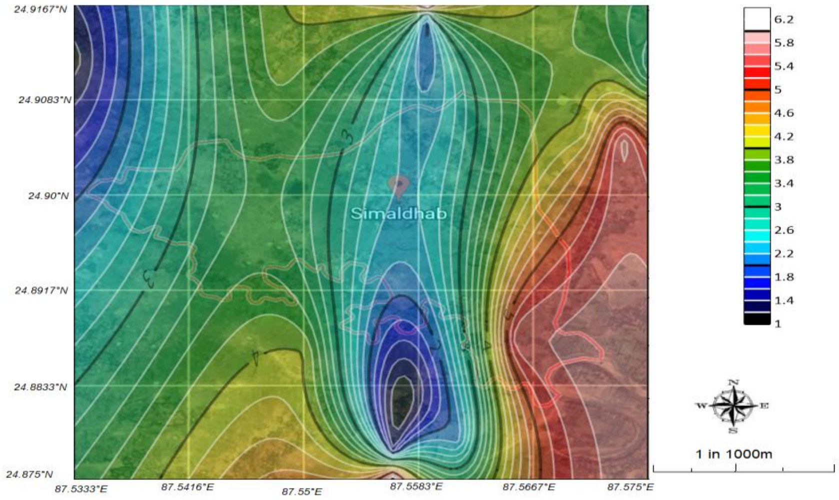


***Fig.6.12.** Pre-Monsoon Phosphate Contour over Base Map*

Fluoride

The significant fluorine bearing minerals are fluorite, apatite, hornblende and micas. The convergence of fluoride in groundwater is restricted because of low dissolvability of fluorides. The dissolvability of fluoride, at 250c, in unadulterated water is just 8.7 ppm of fluoride (Aumeras, 1927). The level of dissolvability is viewed as in the accompanying request; calcium fluoride < magnesium fluoride <sodium fluoride. Groundwater containing under 1000 ppm of all broken up solids typically contains under 0.5ppm fluoride however in certain areas the fixation arrives at over 17.3ppm. By and large the higher fluoride focus is accounted for in dry and semi parched districts. The fluoride shows positive connection with iron and pH and negative relationship with absolute hardness (Chakrabarty and Bhattacharya, 2013). It has additionally been seen that water high in calcium is low in fluoride content (Fix, 1985), i.e., with expanding fluoride focus the convergence of calcium diminishes. The fluoride in water shows negative connection with calcium. fluorine is used by higher life structures in the construction of bones and teeth. According to ongoing suggestions the fluoride content in the scope of 0.6 mg/l to 1.5 mg/l is valuable for human teeth and bones. The fluoride portion reaction bend plainly shows that the extreme as well as lack in fluoride produces unsafe results on human wellbeing
.

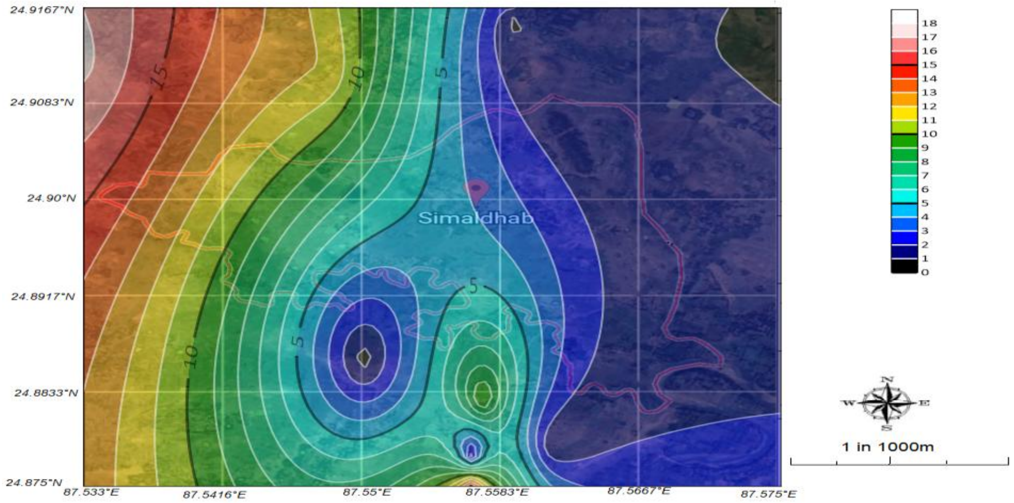
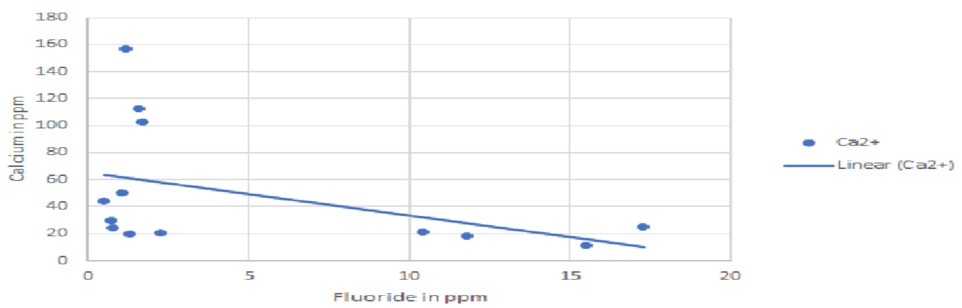


***Fig.6.13.** Pre-Monsoon Fluoride contour over Base Map*



***Graph.6.8.** Relationship of Calcium vs fluoride*

Minor Constituents (Trace Elements)

The constituents which are generally found in indeterminate quantities in water cadmium, cobalt, lead, selenium, copper and zinc. These minor constituents are found in a variety of rock types. Cobalt, nickel and chromium are generally associated with basic and ultra-basic igneous rocks.

Conclusion

Groundwater is generally less susceptible to contamination and pollution as compared to the surface water.The bicarbonate present in water is mainly derived from carbon dioxide which is extracted from air and liberated in the soil through biochemical activities. The stability of minerals also plays an important role in the composition of ground water. The minerals like feldspar go into solution easily than other minerals which are more stable towards weathering and alteration such as Quartz. Since the mechanism of liberation of cations from the minerals structure and at the same time the rate of such

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reaction is not fully known till date, the maximum which can be expected is an empirical correlation. Big diameter dug wells are more produced in the area. Due the fact that recharged tube wells are dependent upon infiltration of water through joint, cracks and fissures. During the field visit of the area, it was observed that the deep dug wells were found to be more perennial in nature whereas the shallow dug wells becomes dry in the summer season. The quality of ground water depends upon the processes and reactions which acted on water from moment of its condensation in the atmosphere to the time of discharge. In the present work, the concentration of major ions, as required have been used to plot a piper-trilinear diagram which reveals that the majority of water is of Ca-Na-HCO_3 type and two samples were found to be Ca-Mg-Cl type. All the parameter selected for the study were well within the permissible limit as prescribed by WHOdrinking water standards and BIS drinking water standards except fluoride, But, what is significant is that, total dissolved solid Mg^{2+}, Ca^{2+} and NO_3^- were found to be higher than desirable limits as prescribed by WHO.So far as F^- is concerned, out of 13 samples gathered for analysis 7 samples were found to have higher fluoride concentration in the entire area. One sample which was collected from the dugwell of the house of Lallan Shah was fluoride deficient. The depth of this dugwell was around 20ft exclusively in the upper soil zone. The other sources of water were either deep dug wells or borewells having higher fluoride concentration. E.A. Keller has given a fluoride dose response curve in 1976 which shows that both the deficiency of fluoride in drinking water and excess fluoride is responsible for dental and skeletal problems in human beings. The recommended dose of fluoride is 0.6 ppm - 1.0 ppm as per WHO standards. And 0.5 - 1.5 ppm as per BIS standards. The excessive fluoride is also manifested in the inhabitants of the area. Many patients of acute skeletal deformation were encountered. The dental problems were found to be most prevalent in the children below 16 years of age. In fact, the fluoride are capable of filling the voids of Hydroxyapatite, which in turn, stabilizes the crystal by providing additional hydrogen bond (Hiremath S.S, Textbook of Preventive and Community Dentistry, Page-378).The preliminary health service has revealed that the children below 16 years of age are facing dental mottling and dental fluorosis. The adult inhabitants of the area are facing the problems of bone deformation and Osteoporosis. The cases of osteoporosis area mostly prevalent in women who are 40 years and plus of age. The preliminary health service corroborates with the analytical findingsalso serves as direct sources, therefore it is clear that a general relationship is always expected between the composition of water and rocks with which it has been in contact.

REMEDIAL MEASURES

The people residing must be ensured potable drinking water either by providing treated supply water through "Har GharNal Jal Yojna" or the peoples should be trained to use Nalgonda technique for removal of excess fluoride using activated charcoal. The entire area is having thick pile of lateritic soil which is considered to be as natural adsorbent of fluoride. The local inhabitants should be trained for removal of excessive fluoride using locally available lateritic soil. The use of lateritic soil is promising alternative because of its low cost and easy implementation (Analia Iriel, Alicia Fernandez Cirelli, Ecotoxicology and environmental safety, volume 149 march 2018, pages - 166-172).

ACKNOWLEDGMENT

The authors are thankful to the Head,University Dept.Of Geology Ranchi university for providing support and guidance. Special thanks are also due to my Supervisor Prof. (Dr.) Bijay singh, University Dept.Of Geology Ranchi university for his motivation, guidance and discussions. Special Thanks are also due to Prof.(Dr.) Pramod kumar singh, Head Department of Geology BIT Sindri for providing facilities, guidance, motivation and support.

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