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Comparative Study of Basaltic and Granitic Aquifers of Dharmabad Taluka of Nanded District, Maharashtra from Groundwater Quality Perspective

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Abstract- The present study was carried out the physicochemical characteristics of basaltic and granitic aquifers of Dharmabad Taluka of Nanded District, Maharashtra (India). The water samples collected from different regions of basaltic and granitic aquifers of Dharmabad during 2007 in pre monsoon season. The physico-chemical parameters such as pH, EC, total dissolved solids, hardness, alkalinity as well as chloride, sulphate, nitrates, sodium, potassium and fluoride have been analyzed. The analytical results indicated considerable variations among the analyzed samples with respect to their chemical composition. The observed values of various physico-chemical parameters of water samples were compared with standard values recommended by BIS (Bureau of Indian Standards). Majority of the samples do not comply with BIS for most of the water quality parameters measured. The fluoride concentration in the underground water of these villages varied from 0.1 to 1.17 mg/l, causing dental fluorosis among people especially children of these villages. The nitrates concentration varied from 12 -178 mg/l. Overall water quality was found unsatisfactory for drinking purposes without any prior treatment in maximum samples.

Index Terms- Groundwater, Physicochemical, Basaltic, Granitic, Aquifers, Dharmabad.

I. INTRODUCTION

Groundwater is a replenishable source of human water supply and it is estimated that approximately one third of the world's population uses groundwater for drinking [5]. Water is an essential resource on earth. Uses of water include household, agriculture, recreational and environmental activities in rural and urban areas, particularly in the developing countries like India because treatment of the same, including disinfection is often not required. It caters to 80% of the total drinking water requirement and 50% of the agricultural requirement in rural India. But in the era of economical growth, groundwater is getting polluted due to urbanization and industrialization. Over the past few decades, the ever-growing population, urbanization, industrialization and unskilled utilization of water resources have led to degradation of water quality and reduction in per capita availability in various developing countries. Due to various ecological factors either natural or anthropogenic, the groundwater is getting polluted because of deep percolation from intensively cultivated fields, disposal of hazardous wastes, liquid and solid wastes from industries, sewage disposal, surface impoundments etc. [1], [2], [3], [4].

The major sources of fluoride in groundwater are fluoride-bearing rocks such as fluorspar, cryolite, fluorapatite and hydroxylapatite [8]. The fluoride content in the groundwater is a function of many factors such as availability and solubility of fluoride minerals, velocity of flowing water, temperature, pH, concentration of calcium and bicarbonate ions in water, etc. [9, 10].

Excessive intake of nitrate and fluoride can cause methemoglobinemia and fluorosis, respectively. The problem is more acute in rural and small urban communities particularly in third world countries. In India alone, 27 845 habitations with approximately 25 million people are supposed to have water supply contaminated with fluoride [11]. Simultaneous occurrence of both fluoride and nitrate in high concentrations in natural water samples has been noticed at several places.

II. MATERIALS AND METHODS

Study Area

Dharmabad is situated 80 km towards south east of Nanded district of Maharashtra state of India. Dharmabad is located at a height of 359 meters (1177 feet) above the mean sea level and between 18.9° North Latitude and 77.85° East Longitude. Mainly two types of rocks viz Basalt and Granite are exposed in this area**.** Selected study area in Dharmabad such as Karegaon, Pipalgaon, Salegaon, Kerkheli 1 and 2, Roshangaon, and Patoda villages are in basaltic region while Belgujari, Dhanora, Ilegaon, Kerkheli 3 and 4, Babulgaon are in granitic region. The sampling locations in study area are shown in Figure 1. Ground water is the major source of water, used for domestic purposes. The litho logy is also responsible for the quality of ground water.

Methodology:

A total twenty groundwater samples were collected from bore wells of study area (Fig.1). Ten samples from basaltic aquifers and ten from granitic aquifers using pre cleaned sterilized poly propylene plastic bottles with necessary precautions. The sampling has been carried out in the month of pre-mansoon 2007. The water samples were immediately dispatched to the laboratory for various physicochemical analysis. The chemical analysis were carried out for pH, electrical conductivity(EC), total dissolved salts (TDS), total alkalinity (TA), total hardness(TH) as well as sodium(Na^+), potassium(K^+), chloride(Cl^-), sulphate(SO_4^{2-}), nitrate(NO_3^-) and fluoride(F^-) according to the standard methods (APHA, 2005). All the experiments were carried out in triplicate. The results were reproducible within ±3% error limit. The pH was measured using pH 600 Millwaukee make (made in Portugal) and Eutech-Cybernetics pH scan meter. Sodium and potassium was determined using ELICO CL-361 flame photometer. Ion meter (ion selective Orion electrode) was used to quantify fluoride and sulphate was determined using ELICO SL-164 Ultraviolet Spectrophotometer [6].

III. RESULTS AND DISCUSSION

The groundwater had no color, odor and turbidity. Taste of the water was slightly brackish at most of the locations. The result regarding the various physico-chemical parameters of ground water collected from Basaltic and Granitic aquifers in pre-monsoon 2007 are given in the Table 1 and 2 respectively.

Hydrogen ion Concentration (pH)

Generally pH of water is influenced by geology of catchments area and buffering capacity of water. The effect of pH on the chemical and biological properties of liquids makes its determination very important. The pH of the groundwater in the basaltic aquifers ranges from 7.1 to 10.2 and in the granitic aquifers the pH ranges from 7.2 to 10.0 shown in figure 2. All samples have pH values more than 7, indicating alkaline nature of the samples. In general, the mean pH values of both the aquifers are more than desirable limits of BIS (6.5-8.5) [7].

Total Dissolved Solids (TDS)

Water with high dissolved solids may induce an unfavorable physiological reaction in the transient consumer and generally are of inferior palatability. The range of TDS values in basaltic and granitic aquifers was found to be in the range of 646-832 mg/L and 646-838 mg/l respectively. The Figure 3 shows that the TDS values are high in granitic aquifers than basaltic aquifers which are more than desirable limits of BIS.

Total Hardness (TH)

The hardness is due to the presence of polyvalent metal ion, e.g. Calcium and magnesium arising from dissolution of minerals. The total hardness of ground water samples from basaltic aquifers was found in the range of 50 - 280 mg/L which is within the range of BIS limit and from granitic aquifers was found in the range of 60-340 mg/l which is further more than desirable of BIS guideline. All ground water samples were found within the desirable limit except sample no 6 in granitic aquifers. Figure 4 shows that average hardness values are higher in granitic aquifers as compare to basaltic aquifers.

Total Alkalinity (TA)

The total alkalinity is mostly due to the presence of bicarbonate. The value of alkalinity in water provides an idea of natural salts present in water. The Alkalinity values in basaltic aquifers and granitic aquifers were found to be in the ranges from 155 to 365 mg/l and 125 to 330 mg/l respectively. The total alkalinity of sample no 1,2,3,6-10 in basaltic aquifer and sample no 1-5 & 8-10 in granite aquifers are higher than desirable limit of BIS (200 mg/l) which are shown in figure 5.

Chloride (Cl^-)

The presence of chlorides in natural waters can mainly be attributed to dissolution of salt deposits in the form of ions (Cl^-). It is the major form of inorganic anions in water for aquatic life. In both aquifers the chloride level is within the desirable limit (250 ppm) of BIS, which indicates less contamination. All samples in basaltic aquifers were found to be high chloride range than granitic aquifers (Figure 6).

Fluoride (F)

Traces of fluorides are present in many waters, with higher concentrations often associated with underground sources. In this work the Fluoride in basaltic aquifers was found in the range of 0.1 to 1.17 mg/l and in granitic aquifers, the range was 0.3 to 1.01 mg/l. The basaltic & granitic aquifer shows that the values are within the permissible limit. The Fluoride values are high in basaltic as compared with granitic aquifers as shown in figure 7. In basaltic aquifers, the three samples (1, 2 & 10) and in granitic sample no (7) are high fluoride values as compared to desirable limit of BIS (1.0 mg/l). If the fluoride concentration in drinking water is more than 1 it would result in fluorosis (dental and skeletal fluorosis) for human beings, especially for children and pregnant woman.

Nitrate (NO_3)

Nitrates are the most oxidized forms of nitrogen and the end product of the aerobic decomposition of organic nitrogenous matter. The ground water contamination is due to the leaching of nitrate present on the surface with percolating water. Johnson and Reynolds (1977) found similar stream nitrate concentrations in stream water from plutonic bedrock (quartz, granite) and from metamorphic and sedimentary bedrock (schist and slate). Figure 8 shows that the nitrate content in basaltic aquifers is well within the desirable limit of BIS (45 mg/l). But in granitic aquifers the ranges of nitrate were found to be 22.2 to 178 mg/l. Because nitrate contamination is common in basic extrusive granite formation and also may be attributed to the percolation of large amount of organic wastes from effluent nitrate fertilizers and other wastes like sewage disposal which on decomposition by microorganism results in the production of nitrates.

Sulphate (SO_4)

Sulphate ions usually occur in natural waters. Sulphates are found appreciably in all natural waters, particularly those with high salt content. Besides industrial pollution and domestic sewage, biological oxidations of reduced sulphur species also add to sulphate content. In the study area, sulphate was found to be within the desirable limit from both basaltic and granitic aquifers (Figure 9).

Sodium and Potassium (Na and K)

Sodium and potassium are the most important minerals occurring naturally. The major source of both the cations may be weathering of rocks besides the sewage and industrial effluents. The sodium and potassium values of basaltic and granitic aquifers were found to be less than 150 mg/l.

Table 1: Physico-chemical parameters of ground water collected from Basaltic aquifers

Sr. No.	pH	EC	TDS	TH	TA	Cl^-	F^-	SO_4^{2-}	NO_3^-	Na^+	K^+
1	7.3	1010	646	280	270	58	1.17	42	12	76	68
2	7.2	1100	704	130	300	88.04	1.01	48	14.5	62	55
3	7.3	1200	768	170	275	56.8	0.74	40.01	18.5	57	2.5
4	10.0	1080	691	260	155	14.2	0.51	10.01	14.5	29.1	4.7
5	7.3	1200	768	253	180	26	0.53	26	20	41	0
6	7.2	1280	819	182	270	48	0.51	42	24.5	43	34
7	7.6	1300	832	50	275	38	0.88	48	30.5	66	5
8	7.6	1020	652	160	365	42.6	0.45	11	33	77.9	84.3
9	10.2	1015	649	99	300	10.2	0.1	22.3	40.25	148.1	0
10	7.1	1100	704	60	320	37	1.01	30	42.15	122	12
Desirable limit of IS:10500:1991	6.5-8.5	--	500	300	200	250	1.0	200	45	--	--

*All the values are expressed in mg/L except pH and EC.
EC is expressed in microsiemens/cm and ND- Not detected

Table 2: Physico-chemical parameters of ground water collected from Granitic aquifers

Sr.No.	pH	EC	TDS	TH	TA	Cl^-	F^-	SO_4^{2-}	NO_3^-	Na^+	K^+
1	7.2	1310	838	267	330	78	0.93	22	178	72	30
2	7.5	1280	819	183	285	21.3	0.64	8.71	50.25	69	21
3	7.6	1010	646	205	325	26.4	0.81	14	80	66	21
4	7.4	1160	742	192	220	28.4	0.69	23	60.25	61.3	10
5	7.4	1160	742	153	280	28.5	0.51	15	64.02	79.7	9.5
6	7.4	1250	800	340	125	28.4	0.61	15.1	69.25	15	8.5
7	7.9	1180	755	210	190	11.2	1.01	16.08	64.25	44.5	15
8	10.0	1290	825	60	330	71	0.3	48	30.25	54	36
9	8.0	1080	691	94	220	42.6	0.4	49	35.5	64	6
10	7.7	1190	761	134	240	36	0.11	20	22.2	125.9	0
Desirable limit of IS:10500:1991	6.5-8.5	--	500	300	200	250	1.0	200	45	--	--

*All the values are expressed in mg/L except pH and EC.
EC is expressed in microsiemens/cm and ND- Not detected

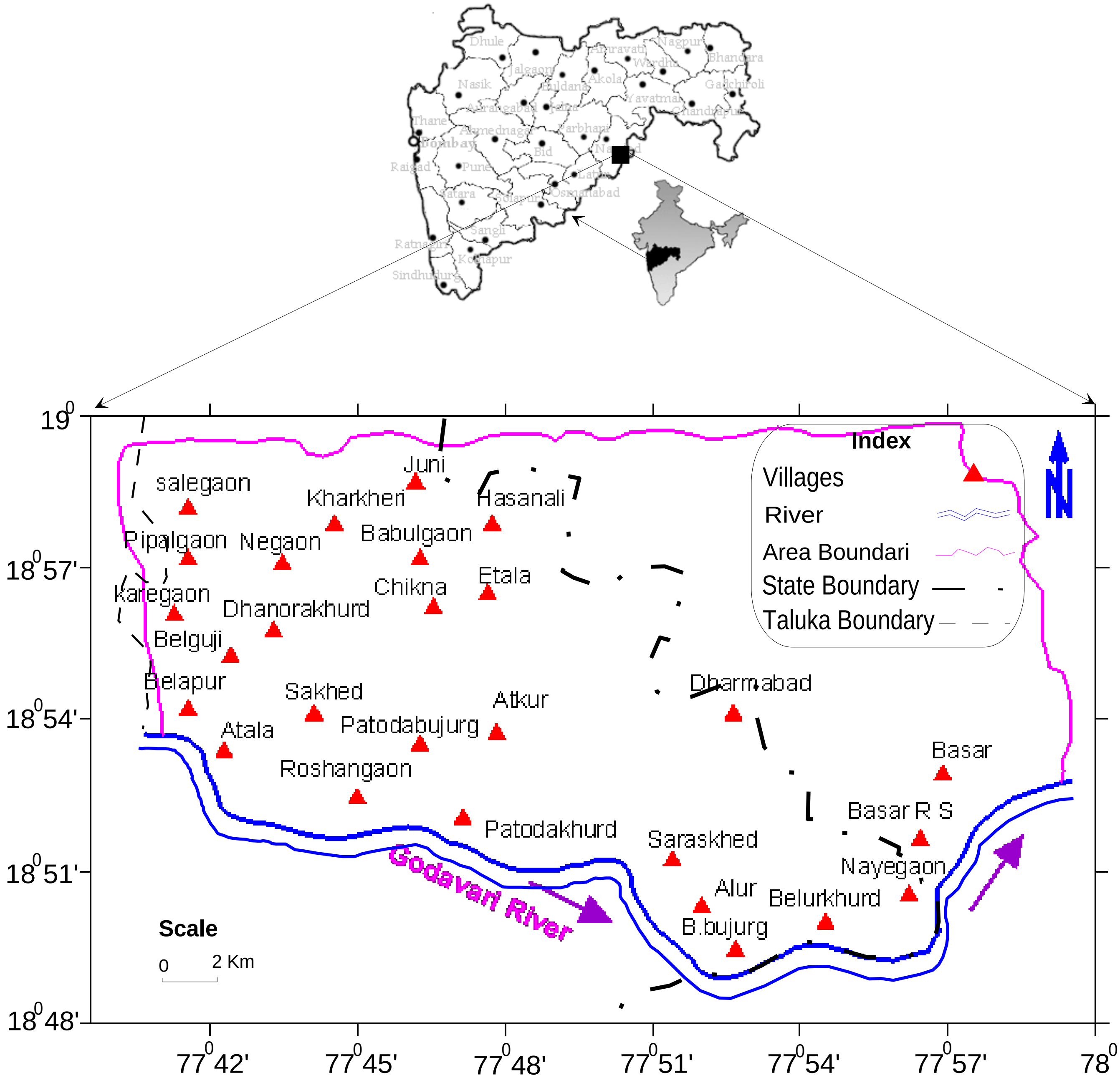

Figure 1: Location map of the study area Dharmabad

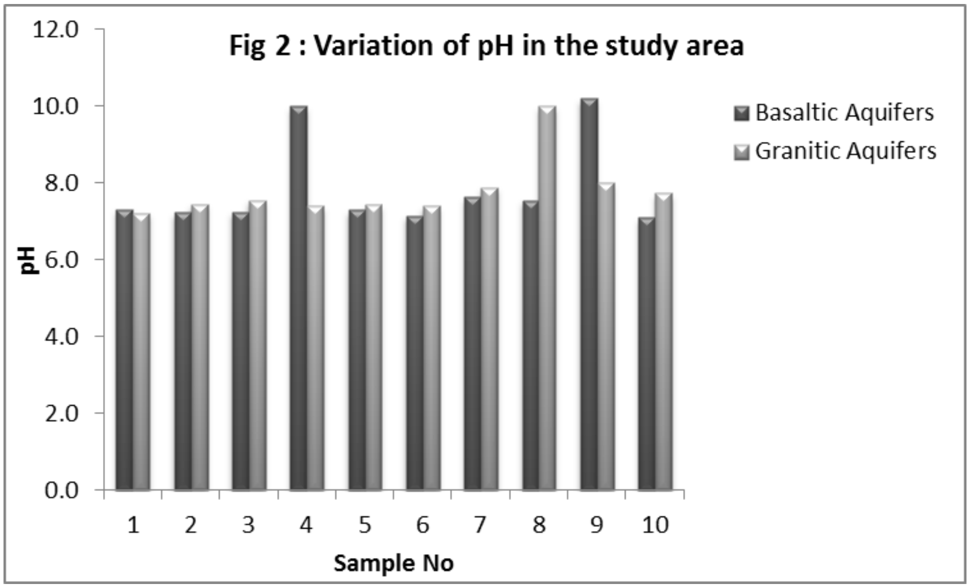

Figure 2: pH variation of the Study Area

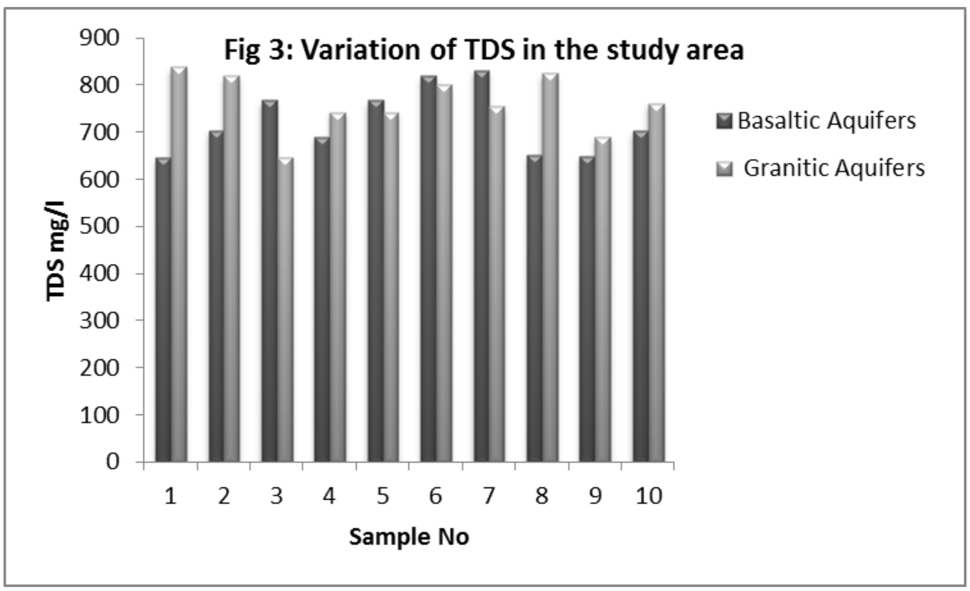

Figure 3: TDS variation of the Study Area

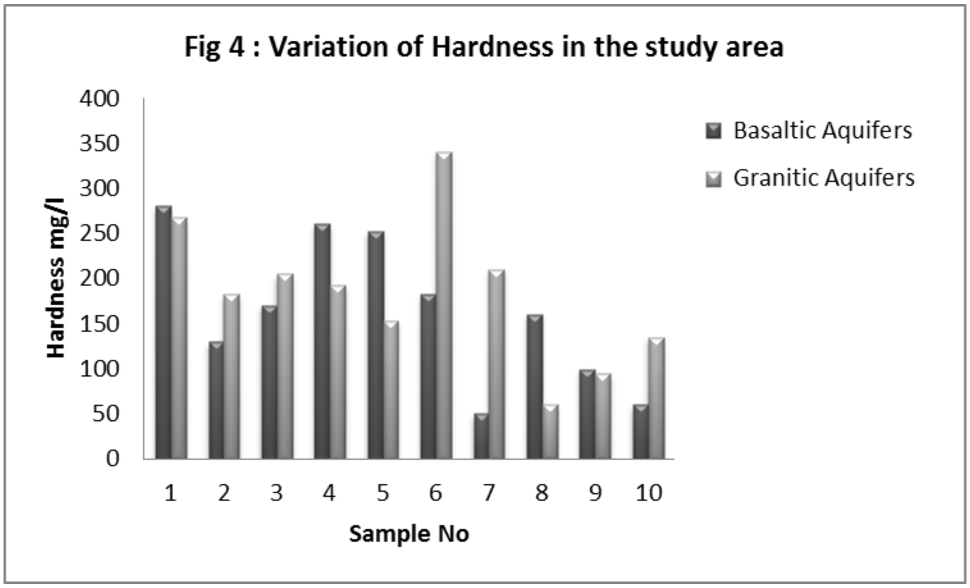

Figure 4: Total Hardness variation of the Study Area

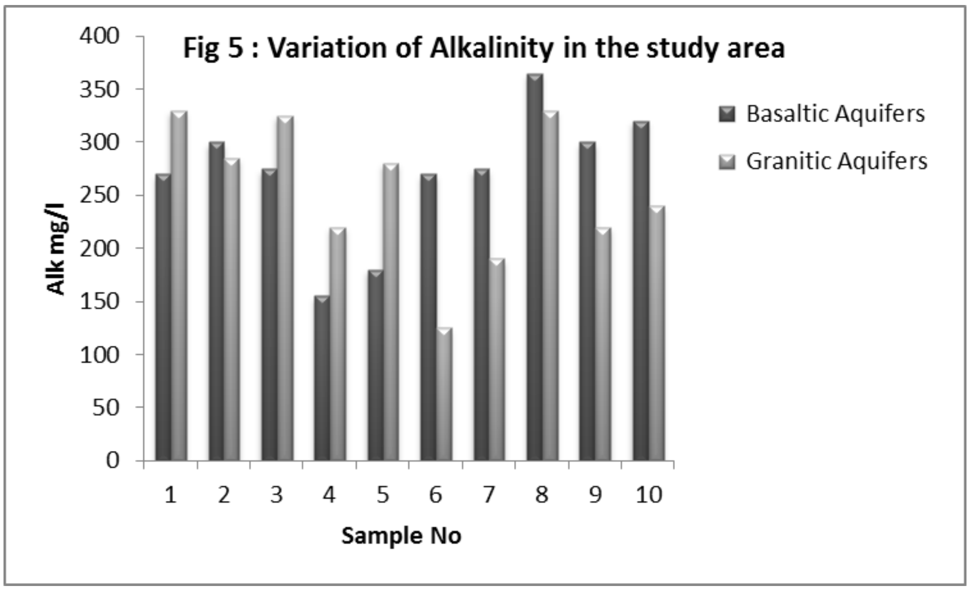

Figure 5: Alkalinity variation of the Study Area

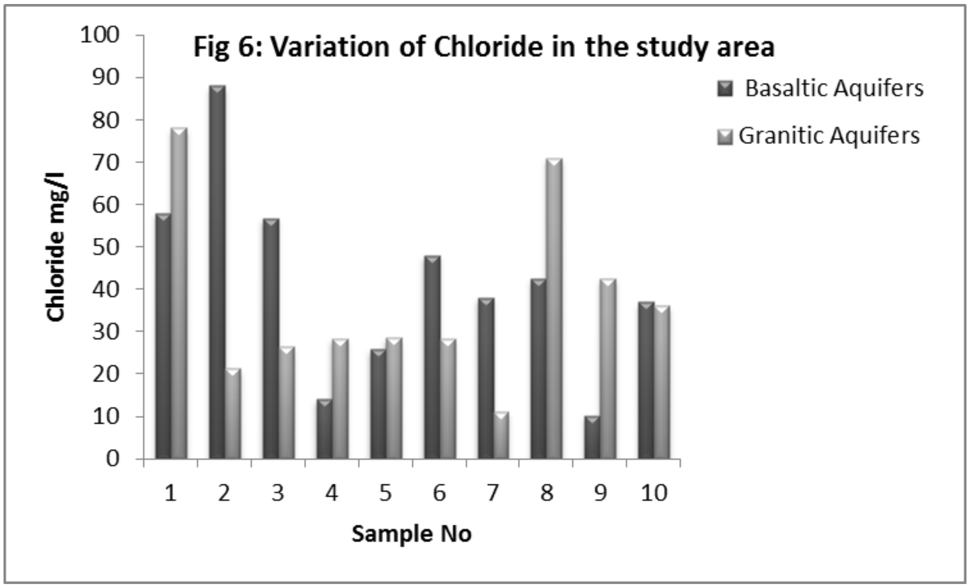

Figure 6: Chloride variation of the Study Area

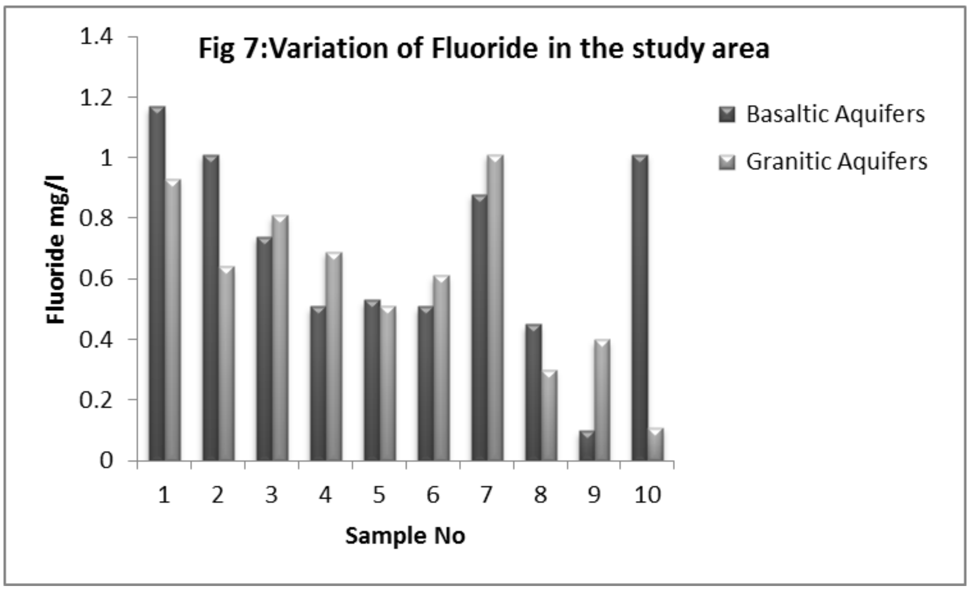

Figure 7: Fluoride variation of the Study Area

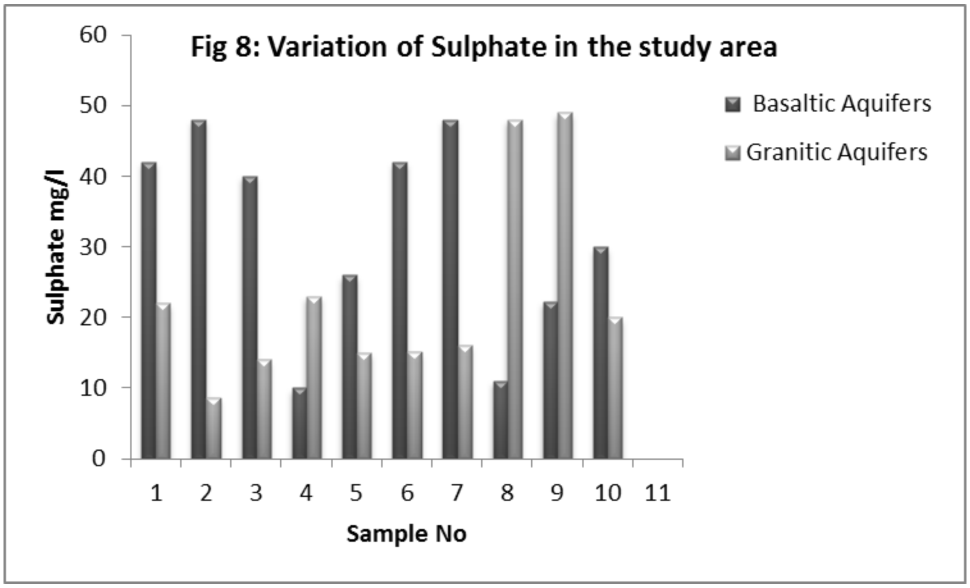

Figure 8: Sulphate variation of the Study Area

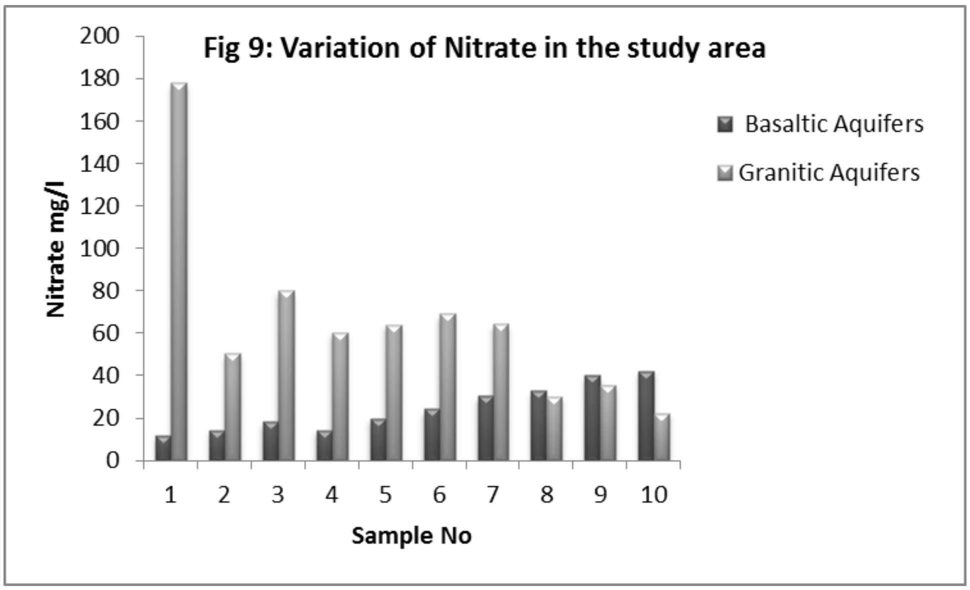

Figure 9: Nitrate variation of the Study Area

IV. CONCLUSION

The present work is an attempt to compare the basaltic and granitic aquifers from groundwater quality perspective. Analyzed results of groundwater samples compare with desirable limit of BIS the value of pH, TDS, TH, TA, F and NO3 are more than desirable limit but within the permissible limit. The average values of EC, TDS, Hardness, Alkalinity, Chloride, and Nitrates are high in granitic aquifers as compare to basaltic aquifers in maximum samples and the average values of Fluoride and Sulphate are high in basaltic aquifers in pre mansoon 2007. The preliminary study indicates that, fluoride content above the safe limit (1 mg/l) in most of the villages of the study area within short distance. Rainwater harvesting is also one of the technique to minimize the fluoride concentration in drinking water. Environmental factors like temperature and rainfall plays an important role on quality of groundwater. Seasonal changes showed significant variation in hydrochemistry of water sources from one season to another season. In granitic aquifers the nitrate contents are high as compare to basaltic aquifers because nitrate contamination is common in basic extrusive granite formation. Use of alternate water sources of basaltic and granitic aquifer which does not contain fluoride, nitrate above safe limit. Awareness programme should be conducted in fluoride affected area. Health survey and Water Quality assessment should be done in fluoride affected area periodically.

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