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HYDROGEOLOGY AND GROUNDWATER QUALITY ASSESSMENT OF ABU ROAD AND SIROHI BLOCKS, DISTRICT SIROHI, RAJASTHAN.

Earth Science

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ABSTRACT

An attempt has been made in the present study, to assess the groundwater potential and quality of Abu Road and Sirohi blocks of district Sirohi, Rajasthan along with the hydrogeological characteristics. Hydrogeologically, the Abu Road block is characterized by the consolidated metasediments and crystalline igneous rocks while Sirohi block is having both consolidated and unconsolidated formations. Physico-chemical characteristics of 32 groundwater samples (14 from Abu Road and 18 from Sirohi) were analyzed to ascertain the suitability of the available groundwater resources for the drinking use. Various water quality parameters were analyzed viz. pH, TDS, Total hardness, alkalinity, nitrate, chloride, and fluoride. Many villages in these blocks do not have safe water quality as the available groundwater sources are having many problem parameters beyond the maximum permissible limits of BIS.

KEYWORDS

Hydrogeology, Groundwater Quality

Introduction :

The concern for the qualitative and quantitative assessment of available groundwater resources has become more pronounced in recent years all over the world. Several countries are facing problem of water crisis. Although, the water resources are abundant on the earth, but the water required for drinking and agriculture purpose is available in a limited quantity. The availability of sustainable sources of water of acceptable quality had a profound influence on human society. The rise and fall of civilizations have been linked to water availability and water scarcity (Issar, 1990). The state of Rajasthan falls under semi-arid to arid climatic conditions and generally it has the scarcity of surface water resources. As such, more than 70% of the population of the state is using the available groundwater resources for agriculture, drinking and industrial uses. However, the quality of potable groundwater, in many parts of the state is not found suitable for the desired use. Many problem parameters (having direct bearing with community health) were found beyond the desirable limits of water quality standards. In the present paper an attempt has been made to assess the groundwater potential and quality of Abu Road and Sirohi blocks of district Sirohi, Rajasthan along with the hydrogeological characteristics.

Hydrogeology and Groundwater Potential:

The Sirohi district is situated in the South West of Rajasthan covers an area of about 5136 sq.km. The district comprises of 5 tehsils, namely:- (1) Sirohi (2) Sheoganj (3) Reodar (4) Abu Road and (5) Pindwara. Geologically, the Sirohi district forms the southwestern extremity of the Delhi synclinorium. The eastern and the central parts of the district are occupied by the metasediments of the Delhi Supergroup of Lower to Middle Proterozoic age, which is represented by Kumbhalgarh Group. These are intruded by mafic and ultramafic rocks and granites of different ages. Further, major part of the Sirohi district is also covered with quaternary and recent alluvium and blown sand (Coulson 1933; Raja Rao et al., 1971; Roy, 1988, 1990; Sharma, 1996; Roy and Sharma, 1999, Sharma, 2004). Abu Road block consist a variety of rocks mainly belonging to Precambrian age. The oldest formations in the block are quartzite, calc-gneiss, and marble of Kumbhalgarh Group of Delhi Supergroup. These rocks are overlain by Sindreth – Ambaji granite and granite-gneiss. The rocks of Sirohi Group are also exposed in the central part of the block, which consist by biotite-schist, phyllite and basement migmatites. These rocks of Delhi Supergroup are intruded by Erinpura granite. The Mt.Abu consist the rocks of Erinpura granitic rocks. Younger granite i.e. Jalore granite are also exposed in the western part of the block. At places rocks of Malani igneous suite i.e. dolerite, basalt, rhyolite, granite etc. are also exposed (GSI, 1980).

Hydrogeologically, the Abu Road block is characterized by the consolidated metasediments and crystalline igneous rocks. The main hydrogeological formations in the area are calc-schists and gneisses and granitic rocks. However at places especially along the West Banas river basin the alluvium formation is also encountered. Similarly the Sirohi block is having both consolidated and unconsolidated formations. Consolidated formations are mainly of metasediments and crystalline igneous rocks while the unconsolidated formations are of alluvium. The main hydrogeological formations in the area are phyllites, schists, granites and alluvium. These metasediments i.e. phyllites and schists are exposed mainly within the Central part of the block. The granites are occupied the Eastern and Western parts of the block while the alluvium is present in the Northern part. These metasediments and granitic rocks are poor aquifer rocks. Primary porosity is almost absent in these rocks. However, the secondary porosity is found to occur within joints, fractures, deformation structures and weathered zones (CGWD, 2013, 2016).

Out of the total area of 838.17 sq. kms. of Abu Road block, only 39.5 % area i.e. 331.06 sq. kms. has been considered as groundwater potential zone area. While out of 1166.75 sq. km.s area of Sirohi block, around 94.5% area is considered as groundwater potential zone area. The net groundwater availability is more in Sirohi block in comparison to Abu Road block. The Total annual recharge is also high in Sirohi block. This is most likely due to the hydrogeological conditions as Sirohi block has alluvium and the metasediments. While the Abu Road block is mainly having metasediments and granitic rocks. Similarly, the Gross Groundwater draft is more in Sirohi block in comparison to Abu Road block, especially for the irrigation purpose. This is most likely due to the fact that the Sirohi block has more agricultural activities while in Abu Road block a major part is covered under hilly region. The Stage of Groundwater Development is more in Sirohi block in comparison to Abu Road block and as such, the Sirohi block is considered as "Over Exploited" block (Table 1). This is most likely due to the fact that the Sirohi block has more agricultural activities and more population than the Abu Road block. Although, the Abu Road block has less percentage of Stage of Groundwater Development but the situation is also not satisfactory as the percentage is close to the "Over Exploited" category (CGWD, 2016).

Table 1 : Groundwater Potentiality of the Study Area

	Abu Road Block	Sirohi Block
Total area of the Block in sq. km.	838.17	1166.75
Groundwater Potential Zone area (in %)	39.5 %	94.5%
Total Annual Recharge in MCM	28.1058	74.7226
Total Natural Discharge in MCM	1.8613	7.4722
Net Groundwater Availability in MCM	26.2445	67.2504

Groundwater Draft for Irrigation in MCM	23.8320	67.4661
Groundwater Draft for Domestic and Industrial Uses in MCM	2.1696	2.6240
Gross Groundwater Draft for All Uses in MCM	26.0016	70.0901
Stage of Groundwater Development SGD (in %)	99.07	104.22
Category on the basis of SGD	Critical	Over Exploited

For understanding the hydrogeology, aquifer nature and water level fluctuations, a total 69 locations (28 locations in Abu Road block and 41 in Sirohi block) were studied and required data during both Pre and Post monsoon period of the year 2016 were collected from these sites. From the study of different sites in these two blocks, it has found that in Abu Road block maximum fluctuation of 17.65 meters was observed at Amthala village (GWL 60) within the schists and minimum fluctuation of 1.15 meter at Surpagla village (GWL 47) in gneiss. Similarly in Sirohi block maximum fluctuation of 24.55 meters was observed at Sinderth village (GWL 33) within the phyllites/schists and minimum fluctuation of 0.80 meter at Mer-Mandwara village (GWL 24) in granite.

It has been also observed that there was not a uniform distribution of fluctuation level within various hydrogeological formations. In Abu Road block the average fluctuation of groundwater level in Younger Alluvium was 5.81 meters, in Phyllite/Schist it was 6.05 meters and in Granite/Gneiss it was 3.79 meters. Similarly in Sirohi block in Younger Alluvium it was 7.21 meters, in Phyllite/Schist it was 10.58 meters and in Granite/Gneiss it was 8.47 meters. Further, it has been observed that in Sirohi block there was higher fluctuation in groundwater level in comparison to Abu Road block. Moreover, the phyllites/schists show high level of fluctuation with respect to younger alluvium or granite/gneiss (Figure 1).

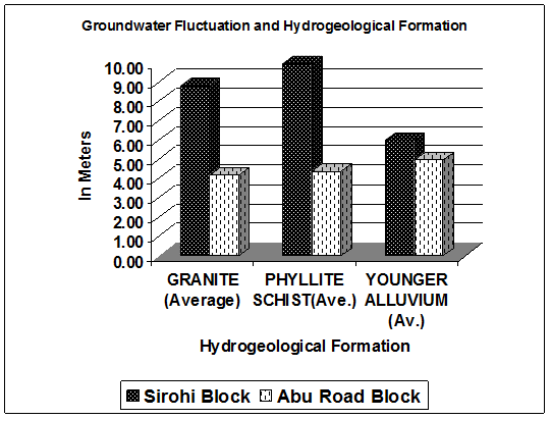


Figure 1 : Comparison of Groundwater Fluctuation with Hydrogeological Formation in Study Area.

Groundwater Quality :

The usefulness of groundwater to a great extent depend on its chemistry, which is influenced by geology, climate, hydrogeology and human activities. The water used for drinking purpose should be free from any toxic elements, living and nonliving organism and excessive amount of minerals that may be hazardous to health. In the present study an attempt has been made to assess the groundwater quality especially for drinking purpose. For this, a total of 32 samples (14 from Abu Road block and 18 from Sirohi block) were collected from different villages. Map 1 and Map 2 show the hydrogeological formations along with the location of analyzed samples in the study area. The procedure employed for the sampling and preservation was as per the standard method (APHA, 1985) To have a comparative study with regard to distribution and behavior of various water quality parameter Pre-monsoon as well as Post-monsoon sampling were performed at the same location. The chemical quality in terms of physico-chemical parameters was determined at the SWACH, Udaipur. The water samples were analyzed for many of the parameters like pH, chloride, nitrate, fluoride, TDS, alkalinity and total hardness. The procedure employed for the physico-chemical analysis was as per the standard procedures. For the assessment of the available groundwater quality and to workout its suitability for the desired use, specifications as suggested by Bureau of Indian Standard (2012) has been used for the comparison. Table 2 and Table 3 give the chemical quality of groundwater samples of the study area.

The pH value in the groundwater samples of Abu Road block show very little variation and ranges from 7.0 to 7.4 only. All the samples were having pH values well within the desirable limit of 6.5 to 8.5. When the pH values of Pre - monsoon samples was compared with the Post-monsoon, it is found that majority of samples do not show much changes except drop of pH values in 2 – 3 samples. Similar situation is found in the Sirohi block also. Here also all of the samples were having pH values well within the desirable limit of 6.5 to 8.5. When the pH values of Pre - monsoon samples was compared with the Post-monsoon, it is found that there is overall drop of pH values in during post-monsoon season.

The chloride concentration is also unevenly distributed. In Abu Road block it varies from 70 mg/l to as high as 1559 mg/1. It has also been found that the concentration of chloride is relatively high in phyllites/schists in comparison to granite and gneiss. In Sirohi block it varies from 40 mg/l to as high as 1199 mg/1. When the chloride values of Pre - monsoon samples was compared with the Post-monsoon, it is found that both in Abu Road block and Sirohi block, there is overall drop of chloride values in during post-monsoon season. Similar situation was found in Sirohi block and at all the location the lowering of concentration has been reported in post-monsoon season. When the chloride concentration of the groundwater samples of Abu Road block were correlated with the Indian specification of drinking water, it is found that only 4 samples (28.57%) in Pre-monsoon sampling and 3 samples in Post-monsoon sampling were having chloride concentration above the desirable limit of 250 mg/l. Otherwise most of the samples were having chloride concentration below 250 mg/l. However, at two places chloride concentration has crossed the maximum permissible limit of 1000 mg/l. Similarly in Sirohi block it is found that 8 samples (44.44%) in Pre-monsoon sampling and 4 samples in Post-monsoon sampling were having chloride concentration above the desirable limit of 250 mg/l. The remaining samples were having chloride concentration below 250 mg/l. However, at three places chloride concentration has crossed the maximum permissible limit of 1000 mg/l.

The Total Hardness concentration is unequally distributed from village to village. In Abu Road block it varies from 148 mg/I to 500 mg/1. In Sirohi block it varies from 118 mg/l to as high as 1000 mg/1. When the Total Hardness values of Pre - monsoon samples was compared with the Post-monsoon, it is found that in Abu Road block there is overall drop of Total Hardness values in during post-monsoon season. Similar situation was found in Sirohi block and at all the location the significant lowering of concentration has been reported in post-monsoon season. When the Total Hardness concentration of the groundwater samples of Abu Road block were correlated with the Indian specification of drinking water, it is found that none of the sample in Pre-monsoon season was having acceptable limit of 200 mg/l i.e. at all the locations the Total Hardness was found above the acceptable limit. In case of Sirohi block it is found that at 2 locations the samples in Pre-monsoon season was having Total Hardness below the acceptable limit of 200 mg/l. Surprisingly in Sirohi block at 3 locations the Total Hardness concentration was very high i.e. above the maximum permissible limit of 600 mg/l. When the Pre and Post monsoon data of Total Hardness are classified as per the classification suggested by Jain and Jain (1988) it has fund that in Abu Road block most of the samples were either falling in the category of Hard and Very Hard. Similar situation was observed in Sirohi block. Here again most of the samples were either falling in the category of Hard and Very Hard.

In Abu Road block the concentration of TDS varies from 315 mg/I as high as 4720 mg/1. In Sirohi block it varies from 160 mg/I to as high as 6000 mg/1. When the TDS values of Pre - monsoon samples was compared with the Post-monsoon, it is found that in Abu Road block there is overall drop of TDS values in during post-monsoon season. Similar situation was found in Sirohi block and at all the location the significant lowering of concentration has been reported in post-monsoon season. When the TDS concentration of the groundwater

samples of Abu Road block were correlated with the Indian specification of drinking water, it is found that 4 of the sample in Pre-monsoon season was having acceptable limit of below 600 mg/l. However in rest of the locations it was above 600 mg/l. Further, at 3 locations the TDS was found above the maximum permissible limit of 1200 mg/l. During the Post-monsoon, the dilution of groundwater has changed the water quality and instead of previous 4 locations, now 11 locations were found with acceptable water quality i.e. below 600 mg/l. Further, in post-monsoon, at only one location (GWL 38) the TDS value was reported above the maximum permissible limit. In Sirohi block only 3 samples in Pre-monsoon season were having acceptable limit of TDS i.e. below 600 mg/l. However in rest of the locations it was above 600 mg/l. Further, at 7 locations the TDS was found above the maximum permissible limit of 1200 mg/l. During the Post-monsoon, the dilution of groundwater has changed the water quality and instead of previous 3 locations, now 7 locations were found with acceptable water quality i.e. below 600 mg/l. Further, in post-monsoon, at 5 locations the TDS value was reported above the maximum permissible limit. When the Pre and Post monsoon data of TDS are classified as per the classification suggested by Bravold et. al., (1967) it has been found that in Abu Road block none most of the samples were either falling in the category of "Good" or "Fair". However at 3 locations the water quality with respect to TDS was of "Unacceptable" category. It has been also observed that there was a change in water quality with respect to TDS during post-monsoon period. In case of Sirohi block during Pre-monsoon only one sample was falling in the suggested categories of "Excellent" water and about 8 samples was falling in the category of "Good" and "Fair" water quality. However at 6 locations the water quality with respect to TDS was of "Unacceptable" category. It has been also observed that there was a change in water quality with respect to TDS during post-monsoon period.

In Abu Road block the Alkalinity varies from 197 mg/l to 380 mg/1 (Pre-monsoon). In Sirohi block it varies from 135 mg/l to 520 mg/1.When the Alkalinity values of Pre - monsoon samples was compared with the Post-monsoon, it is found that in Abu Road block there is overall drop of Alkalinity values in during post-monsoon season. Similar situation was found in Sirohi block and at all the location the significant lowering of concentration has been reported in post-monsoon season. When the Alkalinity values of the groundwater samples of Abu Road block were correlated with the Indian specification of drinking water, it is found that only 2 of the sample in Pre-monsoon season was having acceptable limit of below 200 mg/l. However in rest of the locations it was between 200 mg/l to 400 mg/l. During the Post-monsoon, the dilution of groundwater has changed the water quality but the changes were insignificant. In Sirohi block only 1 sample in Pre-monsoon season were having acceptable limit of Alkalinity i.e. below 200 mg/l. However in rest of the locations it was above 200 mg/l. During the Post-monsoon, the dilution of groundwater has changed the water quality by lowering the concentration of Alkalinity.

The nitrate concentration is more or less equally distributed from village to village. In Abu Road block it varies from 2.0 mg/I to 21 mg/1. In Sirohi block it varies from 2.0 mg/l to 16 mg/1. When the nitrate values of Pre - monsoon samples was compared with the Post-monsoon, it is found that in Abu Road block there is overall drop of nitrate values in during post-monsoon season. Similar situation was found in Sirohi block and at all the location the lowering of concentration has been reported in post-monsoon season. When the nitrate values of the groundwater samples of Abu Road and Sirohi blocks were correlated with the Indian specification of drinking water, it is found that none of the sample either in Pre-monsoon season or Post-monsoon season was having unacceptable limit of i.e. more than 45 mg/l. All the samples in blocks are having safe concentration of nitrate. A comparison of nitrate concentration between the Abu Road block and Sirohi block reveals that the overall quality of water with respect to nitrate is slightly batter in Abu Road in comparison to Sirohi block.

In Abu Road block the fluoride concentration varies from 0.2 mg/l to 1.8 mg/1. In Sirohi block it varies from 0.4 mg/l to 3.5 mg/1. When the fluoride values of Pre - monsoon samples was compared with the Post-monsoon, it is found that in Abu Road block there is overall drop of fluoride values in during post-monsoon season. Similar situation was found in Sirohi block and at all the location the significant lowering of concentration has been reported in post-monsoon season. When the fluoride values of the groundwater samples of Abu Road block were correlated with the Indian specification of drinking water, it is found that at 2 locations inn Pre-monsoon season the value was below 0.5 mg/l which is unsafe for health further, again at 2 locations the fluoride was beyond the maximum permissible limit of 1.5 mg/l. However, in rest of the locations it was between 0.5 mg/l to 1.5 mg/l. During the Post-monsoon, the dilution of groundwater has changed the water quality and at many places the fluoride concentration dropped to below 0.5 mg/l which is also unsafe for health point of view. In Sirohi block at 4 locations the fluoride was found beyond the maximum permissible limit of 1.5 mg/l. However, in rest of the locations it was between 0.5 mg/l to 1.5 mg/l. During the Post-monsoon, the dilution of groundwater has changed the water quality and at 2 places the fluoride concentration dropped to below 0.5 mg/l which is also unsafe for health point of view.

The inter-parameter relationship analysis reveals that there is a clear cut positive relationship between many parameters. TDS show positive relationship with chloride, nitrate, alkalinity, total hardness and pH. Chloride shows a positive correlation between all parameters except pH. Fluoride does not show significant correlation with other elements except nitrate and chloride. On the other hand negative correlation was observed between fluoride and Total hardness and fluoride and pH. Total alkalinity has significant positive correlation with TDS, nitrate, total hardness and chloride. However, the alkalinity has insignificant correlation with fluoride and a negative correlation with pH. Likewise the total hardness show significant positive correlation with TDS, chloride, nitrate, alkalinity and pH. However, a negative correlation has been noticed with fluoride.

It has also been observed that in Abu Road block the average concentration of parameters like chloride, alkalinity, Total hardness, TDS fluoride and nitrate are relatively high in hydrogeological formation of phyllites/schist comparison to other formations i.e. granite and younger alluvium. However, the water level fluctuation was higher in younger alluvium. More or less same type of scenario was observed in Sirohi block that the average concentration of parameters like chloride, alkalinity, Total hardness, TDS fluoride and nitrate are relatively high in hydrogeological formation of phyllites/schist comparison to other formations i.e. granite and younger alluvium. However, here the water level fluctuation was higher in phyllites/schist instead of younger alluvium.

Conclusion :

The water quality analysis of groundwaters of study area reveals that in many villages the quality of water is not suitable for the drinking purpose as it contains many water quality parameters beyond the permissible limit. Although in post-monsoon season due to the recharge from rain water and subsequent dilution of groundwater resources, at few villages the water quality got improved but still it can not be considered as safe from heath point of view as few of the parameters like TDS, Total hardness, Chloride and fluoride remained in undesirable concentration. These parameters may have adverse health consequences (Bokina et. al., 1965; Underwood, 1977; Keller, 1979; W.H.O, 1984; Durve et, al,. 1991; Singh and Saimbi, 1988 , Machoy, et.al., 1991; Mishra, 1999; Agrawal and Vaish, 1999).

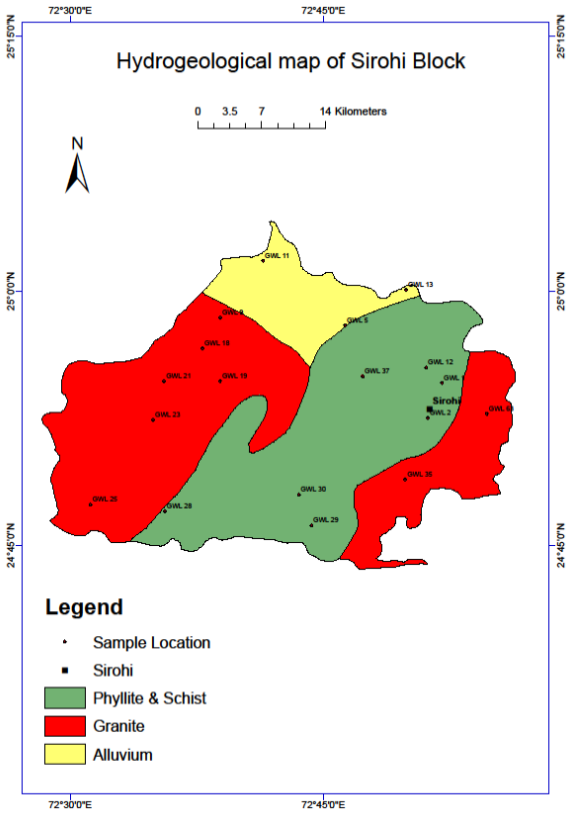
For sustainable groundwater resource management and to improve the drinking water quality in the rural areas of the blocks it is desirable to adopt adequate strategies and time bound programs. These include (i) artificial recharge of ground water by arresting rain water run-off during monsoon seasons should be the policy directive in all areas (ii) in the villages where the fluoride concentration is high, there is a need to promote the domestic based and community based defluoridation techniques (iii) revival of traditional ground water storage system i.e. *Baori*, open wells, *Tanka* etc for rainwater conservation for use in day to day life will reduce ground water draft (iv) awareness programme and training on rainwater harvesting will be beneficial to check decline in water level and justified use (v) modern agricultural management techniques have to be adopted for effective and optimum utilization of the water resources (vi) a time based priority program to provide safe-drinking water based on principles of scientific source locations and well construction in convergence with the government departments shall help to improve the health and hygiene status of people inhabiting such areas.

Table 2: Sample Location details and Chemical Analysis of Water Samples from Pre and Post Monsoon Season of 2016, Abu Road Block

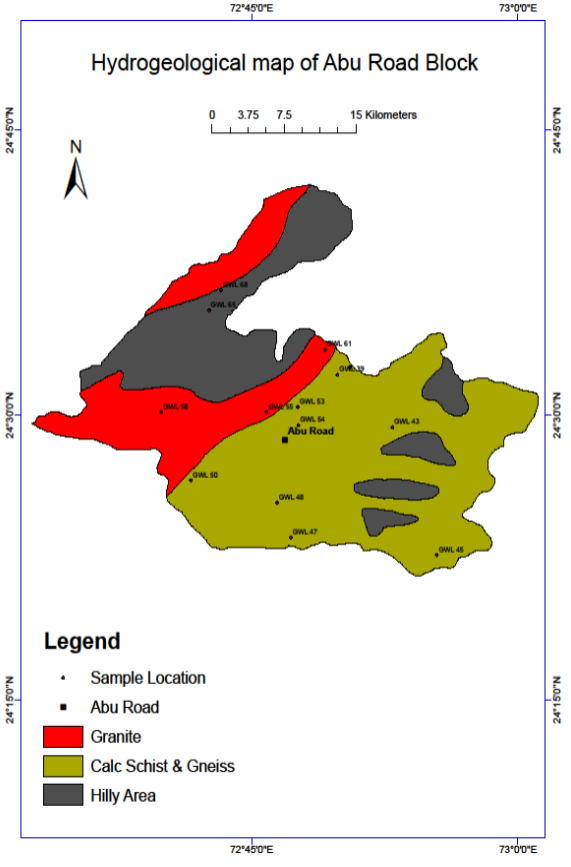
S.NO.	GWL	Village Name	Hyd. Formation	pH		Chloride		Alkalinity		Total Hardness		TDS		Fluoride		Nitrate	
				Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	GWL 38	Kivarli	Schist	7.3	7.2	1249	499	340	325	500	468	4720	2360	1.0	1.0	19.0	14.0
2	GWL 39	Kivarli	Younger Alluvium	7.0	7.0	175	70	200	240	240	220	720	320	0.8	0.4	4.0	3.0
3	GWL 43	Kyari	Phyllite/Schist	7.0	7.0	119	80	280	286	272	148	480	320	0.9	0.2	3.0	3.0
4	GWL 45	Jamboori	Calc-schist	7.1	7.1	129	78	380	376	384	365	480	400	0.4	0.4	2.0	2.0
5	GWL 47	Surpagla	Gneiss	7.0	7.0	99	87	280	278	304	300	320	315	0.7	0.4	3.0	3.0
6	GWL 48	Siyawa	Schist	7.0	7.0	124	122	320	300	300	288	760	600	1.3	1.3	3.0	3.0
7	GWL 50	Wasda	Younger Alluvium	7.0	7.0	99	84	320	315	296	284	720	560	0.6	0.5	2.0	Traces
8	GWL 53	Akrabhatta	Gneiss	7.2	7.1	349	190	380	368	460	320	2240	760	0.5	0.5	7.0	6.0
9	GWL 54	Shantivan	Younger Alluvium	7.1	7.1	249	200	300	299	400	360	440	360	0.2	0.2	5.0	3.0
10	GWL 55	Ganka	Granite	7.0	7.0	175	120	320	314	328	240	880	560	1.2	0.5	3.0	2.0
11	GWL 58	Girwar	Phyllite/Schist	7.0	7.0	319	256	280	265	340	320	840	520	1.8	1.5	5.0	4.0
12	GWL 61	Mudarla	Gneiss	7.0	7.0	1559	453	360	332	280	278	1320	680	1.8	1.7	21.0	18.0
13	GWL 65	Mt. Abu	Granite	7.3	7.1	144	99	224	221	240	208	760	520	1.0	0.3	3.0	2.0
14	GWL 68	Delwara, Mt.abu	Granite	7.4	7.2	99	90	200	197	204	200	720	400	0.7	0.5	3.0	2.0

Table 3 : Sample Location details and Chemical Analysis of Water Samples from Pre and Post Monsoon Season of 2016, Sirohi Block

S.NO.	GWL	Village Name	Hyd. Formation	pH		Chloride		Alkalinity		Total Hardness		TDS		Fluoride		Nitrate	
				Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	GWL 1	Sirohi	Gneiss	7.0	7.0	49	40	140	135	120	120	240	160	0.7	0.6	8.0	6.0
2	GWL 2	Sirohi	Phyllite Schist	7.4	7.2	424	260	460	360	540	272	1640	1620	1.0	1.0	16.0	13.0
3	GWL 5	Udd	Younger Alluvium	7.1	7.0	124	121	260	235	220	215	560	465	1.1	1.0	7.0	6.0
4	GWL 9	Nawara	Granite	7.3	7.0	1199	220	440	380	544	264	3960	1840	2.2	1.5	13.0	12.0
5	GWL 11	Varada	Younger Alluvium	7.2	7.1	1102	280	400	380	648	260	2840	2600	0.8	0.8	11.0	9.0
6	GWL 12	Mandwa	Phyllite Schist	7.2	7.1	249	240	440	435	312	280	880	876	0.7	0.6	7.0	5.0
7	GWL 13	Gol	Younger Alluvium	7.0	7.0	175	46	280	278	120	118	640	520	1.7	1.0	6.0	6.0
8	GWL 18	Mohhabat nagar	Granite	7.2	7.0	99	44	420	300	280	232	760	400	0.6	0.4	3.0	3.0
9	GWL 19	Chaduwal	Granite	7.3	7.2	1124	220	520	515	800	400	4600	1960	1.3	1.3	11.0	9.0
10	GWL 21	Phugani	Granite	7.2	7.1	349	240	320	239	512	360	1200	1140	1.3	1.2	5.0	4.0
11	GWL 23	Jaila	Granite	7.0	7.0	189	80	376	320	288	268	520	440	1.9	1.8	6.0	6.0
12	GWL 25	Rampura/sildar	Schist	7.1	7.0	549	390	370	368	380	280	1520	1080	1.3	1.2	8.0	6.0
13	GWL 28	Sanpur	Granite	7.1	7.0	104	80	370	364	328	220	720	480	1.4	1.2	3.0	2.0
14	GWL 29	Mera Krishnaganj	Phyllite Schist	7.2	7.0	199	70	344	240	432	240	640	440	0.7	0.6	3.0	3.0
15	GWL 30	Velangari	Granite	7.2	7.2	249	235	340	322	408	400	1040	920	0.5	0.4	5.0	4.0
16	GWL 35	Makroda	Granite	7.2	7.2	274	267	360	345	420	416	960	870	3.5	2.8	7.0	6.0
17	GWL 37	Angore	Granite	7.0	7.0	125	120	360	324	268	240	680	630	0.8	0.8	5.0	3.0
18	GWL 63	Balda	Phyllite Schist	7.2	7.2	849	232	260	258	1000	376	6000	2345	1.2	1.2	16.0	13.0



Map 1 : Hydrogeology and Location of Analyzed Samples (Sirohi Block)



Map 2 : Hydrogeology and Location of Analyzed Samples (Abu Road Block)

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