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Assessment of Physico-Chemical Properties of Ground Water in Granite Mining Areas in Goramachia, Jhansi, UP, India

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Abstract

A study was carried out in granite mining area in Jhansi (Goramachia) to evaluate the current status of physicochemical contaminants and their sources in groundwater. Groundwater samples collected from mining and residential area in 6 different locations were analyzed. There are almost 30 crushers running in the study area. The location (Goramachia) is situated at 10 km north-east of Jhansi city. In each location of mining and residential areas, three samples were collected at various distances. The physico-chemical parameters such as pH, DO, EC TDS, alkalanity, turbidity, calcium hardness, magnesium hardness, total hardness, nitrate, fluoride, iron and chloride have been analyzed. The results showed that among the mining and the residential locations, many of the estimated physico-chemical parameters of mining and residential areas are more or less with the permissible limits of WHO.

Keywords: Physico-chemical contaminants, ground water, Goramachia, Jhansi.

Introduction

Water recourses have played critical and vital role throughout history in the growth and context continue to be a factor of important in the economic growth of all the contemporary societies. In societies like our India with developing economics, the optimum development, efficient utilization and effective management of their water resources should be the dominant strategy for economic growth, but in recent year's unscientific management and use of this resources for various purpose almost invariably has created undesirable problems in its wake, water logging and salinity in the case of agriculture use and environment pollution of various limits as a result of mining, industries and municipal use.

Water is one of the most indispensable resources and is the elixir of life. Water constitutes about 70% of the body weight of almost all living organism. Life is not possible on this planet without water. It exists in three states namely solid, liquid and gas. It acts as a media for both chemical and biochemical reactions and also as internal and external medium for several organisms. About 97.2% of water on earth is salty and only 2.8% is present as fresh water from which about 20% constitutes ground water. Ground water is highly valued because of certain properties not possessed by surface water[1].

Significance of Study: The present work attempts to study the physicochemical properties in ground water of Goramachia which is situated 10 km from Jhansi city. The results of the study will help in gathering significant data pertaining to the aspects quality status of ground water of Goramachia. The outcome of the study may help the ground water conservation managers, technocrats and urban planners to improve and restore the ground water.

Objective: To determine the physico-chemical characteristic of different ground water sample in and around granite mining area of Goramachia village.

Material and Methods

Study Area: The present region of Bundelkhand lies between approximately 23.10 degrees and 26.27 degree north latitude and 78.4 degree and 81.34 degree east latitude and comprises four district of Chitrakut divisions, three districts of Jhansi division, five districts of Sagar division and one district of Gwalior division. The cultural Bundelkhand, however, spread beyond this region and touch partially several of the adjacent districts, namely Bhind, Gwalior, Morena, Shivpuri, Guna, Narsingpur, Hosangabad, Jabalpur and Satna etc.

Geographical Information of Goramachia district Jhansi: Jhansi is located at 25.4333 N 78.5833 E. It has an average elevation of 284 meters (935 feet). Jhansi is located in the plateau of central India which is mainly rocky area with so many minerals underneath. The city has a natural slope in the north as it lies on the south western border of the vast Tarai plains of Uttar Pradesh. The elevation rises on the south. The land is suitable for citrus species fruits. Crops include wheat, pulses, peas, oilseeds. The region relies heavily on Monsoon rains for irrigation purposes. Under an ambitious canal project (Rajghat canal), the government is constructing a network of canals for irrigation in Jhansi and Lalitpur and some area of Madhya Pradesh. Whereas Goramachia is about 10 km north

east direction from Jhansi city and located at 25.2812 N and 78.4035 E. It has an average elevation of 692 feet. Goramachia is a small village in Badagaon Mandal in Jhansi District in Uttar Pradesh State. Badagaon, Niwari, Jhansi, Chirgaon, are the nearby Towns to Goramachia.

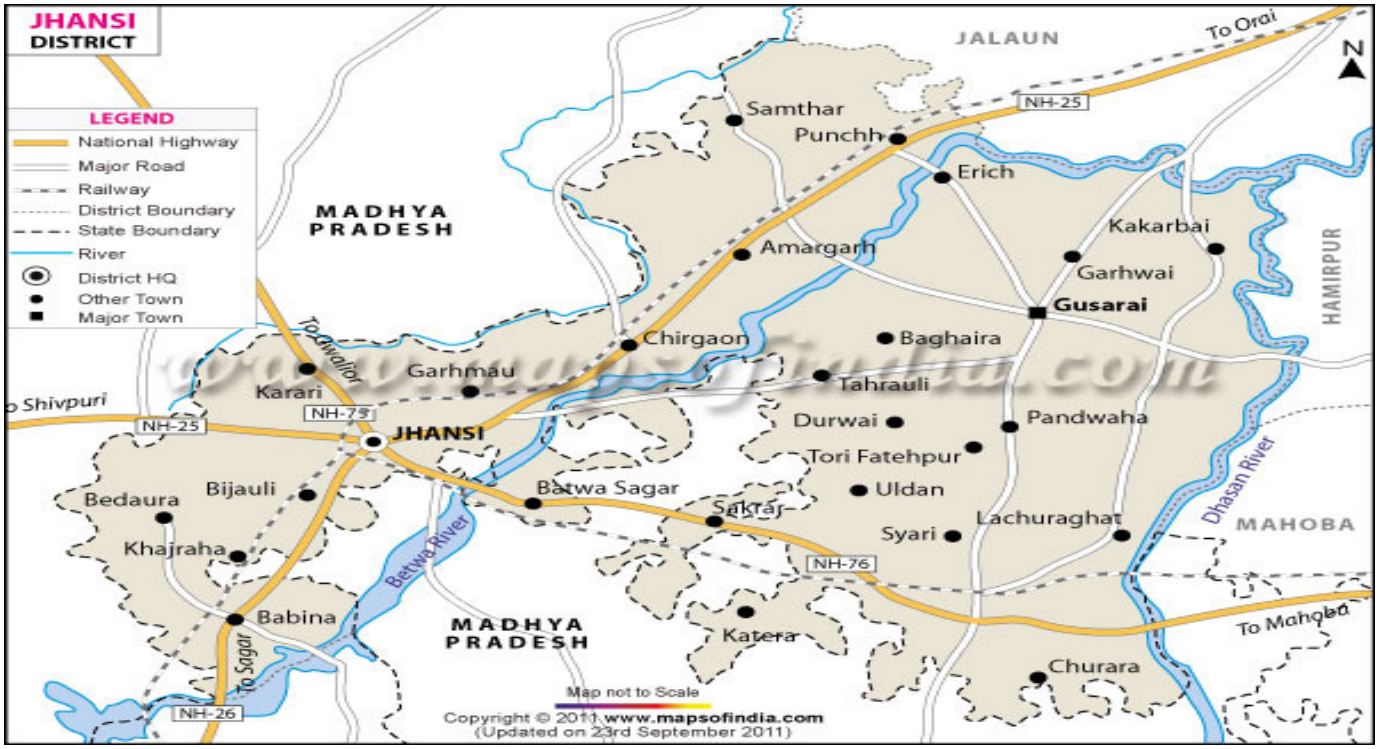
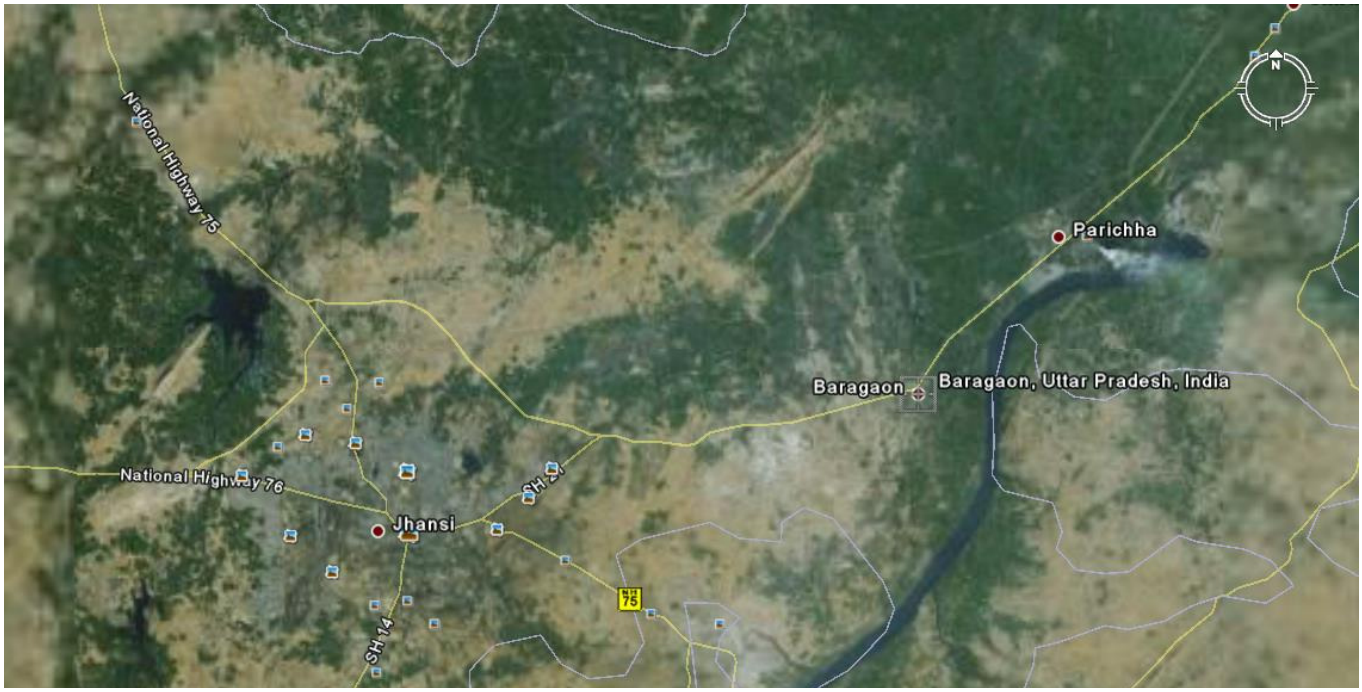


Figure-1
Map of Jhansi District



Figure–2
Badagaon Mandal in Jhansi District

Figure-3
Sampling areas of Goramachia village in Badagaon mandal, Jhansi District

Climate: Being on a rocky plateau, Goramachia experiences extreme temperatures. Winter begins in October with the retreat of the Southwest Monsoon (Goramachia does not experience any rainfall from the Northeast Monsoon) and peaks in mid-December. The mercury generally reads about 4 degrees minimum and 21 degrees maximum. Spring arrives by the end of February and is a short-lived phase of transition. Summer begins by April and summer temperatures can peak at 47 degrees in May.

Water Sampling: During the study, sampling was carried out at the two different sites of Goramachia (mining and residential) in 3 both sites. The sampling and analysis work for this study has been started in the month of January 2010 and extended up to September 2010. Samples were collected in pre cleaned 2 L polythene bottles with necessary precautions[2].

Sample Container: For sampling plastic bottles were used. Before sampling, bottle were soaked in Hcl and rinsed with double distilled water. Necks of the bottle were tightly sealed.

Sample Collection: For sampling, the bottle has been rinsed 2 to 3 times for the sample to be examined then after samples were collected from different three sites of mining and residential area of Goramachia. All samples are collected from hand pump which are used for drinking water, situated in different three sites of study area. The complete information was recorded about the source and the condition under which the samples were collected.

Water Analysis: During the present study ground water sample were collected and analyzed for various physiochemical parameters to ascertain the characteristics of the ground water of Goramachia, Jhansi. All the samples were examined to determine pH, DO, EC TDS, Alkalanity, Turbidity, Calcium Hardness, Magnesium Hardness, Total Hardness, Nitrate, Fluoride, Iron and Chloride using standard methods[3].

Result and Discussions: The result regarding the mean values of the various physico-chemical parameters of ground water collected in various month are given in the table 1.

pH: pH is the measure of acidity or alkalinity of water. The pH values of residential area are within the permissible limits of WHO standards (7.0–8.5). The value of pH found between 7.05 – 7.71. This may be attributed to different types of buffers normally present in the ground water[4]. The variations in pH are relatively small. However, the values reveal to the mining areas are slight alkaline nature of the ground water[5]. The mild alkalinity indicates the presence of weak basic salts in the soil[6]. The mild alkaline nature suggests that approximately 95% of CO_2 in water is present as bicarbonate[7]. pH is considered as an important ecological factor and provides an important piece factor and piece of information in many type of geochemical equilibrium or solubility calculation[8].

Alkalanity: The ranges of alkalinity have been found in between 164-396 mg/l in mining and residential area of Goramachia. In mining area it has been found between the ranges of 221-242 mg/l where as in residential area Goramachia it has been found 164-396 mg/l, which is also shown in table 1.

T.D.S: The total dissolved solids (TDS) values of sampling area are more or less whiten the permissible limits of WHO (500 ppm) except one mining are very high concentration. The high TDS value may also be due to the presence of granitic materials in that area, which is resistant to dissolution[9]. High levels of TDS may aesthetically be unsatisfactory for bathing and washing.

The table 1 shows that the residential area TDS values are between 226-475 mg/l where as the mining areas of Goramachia are between 224-1790 mg/l, the sample A2-G-4of mining areas are showing very high concentration of TDS in every months of sampling where as the A2-G-5 and A2-G-6 are not detected in the month may.

E.C: The importance of electrical conductivity (EC) is its measure of salinity which greatly affects the taste and thus has a significant impact on the user acceptance of the water as potable[10]. Electrical conductivity talks about the conducting capacity of water which in turn is determined by the presence of dissolved ions and solids. Higher the ionizable solids, greater will be the EC. The WHO permissible limit for EC in water is 600 µmhos cm-1. When this exceeds 3000 µmhos cm-1, the germination of almost all the crops would be affected and it may result in much reduced yield[11].

Electrical conductivity of water is a direct function of its total dissolved salts[12]. The values of EC in residential area are between 974-645 µmhos cm-1 whereas the mining area EC are between 878-469 µmhos cm-1.

Turbidity: The ranges of turbidity have been found in between 2.3-1.1 NTU in mining and residential area of Goramachia. In residential area it has been found between the ranges of 2.0-1.1NTU where as in mining area Goramachia it has been found 2.3-1.5 NTU, which is also shown in table 1.

Dissolve Oxygen: The condition in case of dissolved oxygen (DO) is slightly complicated since in contrast to other pollutants, the quality of water is enhanced if it contains more oxygen. An ideal DO value of 5.0 mg/l is the standard for drinking water[13]. In natural waters, DO values are varying according to the physicochemical and biological activities. The DO values of mining area are more or less below the permissible limits of WHO (6 ppm).

The ranges of DO have been found in between 7.8-4.8 mg/l in mining and residential area of Goramachia. In residential area it has been found between the ranges of 7.7-5.0 mg/l where as in mining area Goramachia it has been found 7.8-4.8 mg/l.

Calcium Hardness: Calcium is from natural sources like granitic terrain which contain large concentration of this element. The result shows that calcium values for most samples in mining and residential area are lie within the level of WHO (100 ppm) except January and may of mining areas of Goramachia. Calcium is ion of total hardness and hence they are interrelated.

High values of calcium hardness in study area may be due to the cationic exchange with sodium[14]. However, low values do not mean that it is not influenced by the pollutants but it might be due to the reverse cationic exchange with sodium. (i.e.) sodium ions replace Ca ions thereby reducing their concentration in ground water after percolation. In the study, values of calcium hardness are within the permissible level of WHO. The ranges of calcium hardness have been found in between 237-48 mg/l in mining and residential area of Goramachia. In residential area it has been found between the ranges of 94-48 mg/l where as in mining area Goramachia it has been found 237-55 mg/l.

Magnesium Hardness: Magnesium is from natural sources like granitic terrain which contain large concentration of these elements. The result shows that magnesium values for most samples in mining are lie very well within the safe limits of WHO (150 ppm).

Magnesium is supposed to be non toxic at the concentration generally met in natural water. The ranges of magnesium hardness have been found in between 88-11 mg/l in mining and residential area of Goramachia. In mining area it has been found between the ranges of 88-22 mg/l where as in residential area Goramachia it has been found 32-11 mg/l.

Total Hardness: Hardness is the property of water which prevents the lather formation with soap and increases the boiling points of water[15]. The Total Hardness is an important parameter of water quality whether it is to be used for domestic, industrial or agricultural purposes. It is due to the presence of excess of Ca, Mg and Fe salts. The carbonate and bicarbonate concentrations are useful to determine the temporary hardness and alkalinity. The alkalinity is mainly due to bicarbonates. The maximum total hardness value was observed as 297 mg/l at residential area and minimum was 228 mg/l at mining area.

Nitrates: The high nitrogen content is an indicator of organic pollution. It results from the added nitrogenous fertilizers, decay of dead plants and animals, animal urines etc. They are all oxidized to nitrate by natural process and hence nitrogen is present in the form of nitrate. The increase in one or all the above factors is responsible for the increase of nitrate content[16]. The ground water contamination is due to the leaching of nitrate present on the surface with percolating water.

The nitrate content of mining and residential is well within the permissible limit of WHO (50 ppm) except in the month of January in mining area where as the in month of may the samples A2-G-4 and A2-G-5 are not detected. The low nitrate content may be due to the less usage of nitrogen fertilizers and less disposal of wastes around study areas[17]. The concentration varies from 83 ppm to 6.3 ppm.

Table-1
Month Wise Data

Month	Sites	Water Quality Parameters												
January	Mining Sites of Jhansi	pH	Alkalanity	TDS	EC	Turbidity	DO	Calcium Hardness	Magnesium Hardness	Total Hardness	NO_3^-	F^-	Fe	Cl^-
	A1- G-1	7.57	232	348	450	2.0	7.7	72	19	260	10	1.0	0.16	22
	A1- G-2	7.50	238	226	438	1.8	7.4	79	21	284	9	0.83	0.14	25
	A1- G-3	7.48	230	234	454	1.9	7.0	74	18	259	10	1.05	0.11	19
	A2-G-4	7.34	396	1248	1500	1.8	7.8	204	82	852	74	0.39	0.12	22
	A2-G-5	7.30	370	803	1474	1.9	7.5	186	88	826	72	0.28	0.14	00
	A2-G-6	7.40	388	812	1490	1.5	7.2	193	80	811	83	0.31	0.11	00
May	A1- G-1	7.59	230	475	730	1.2	6.2	94	15	296	25	0.27	0.16	36
	A1- G-2	7.43	236	385	738	1.4	6.5	91	17	297	27	0.23	0.19	31
	A1- G-3	7.55	242	375	720	1.1	6.8	90	11	270	31	0.29	0.23	39
	A2-G-4	7.18	366	1790	2750	2.0	6.0	237	40	760	25	0.72	0.14	35
	A2-G-5	7.35	358	00	00	2.3	5.9	230	44	755	00	0.77	0.16	00
	A2-G-6	7.05	372	00	00	2.0	6.2	227	45	752	00	0.65	0.11	00
September	A1- G-1	7.71	228	322	495	1.5	5.1	56	29	252	6.3	1.05	0.43	24
	A1- G-2	7.68	221	250	483	1.6	5.6	52	25	233	6.7	1.10	0.41	27
	A1- G-3	7.65	236	246	476	1.5	5.0	48	32	251	7	1.02	0.38	24
	A2-G-4	7.35	176	329	485	1.8	4.9	61	24	252	25	0.12	0.69	28
	A2-G-5	7.32	179	248	480	1.6	4.8	55	22	228	22	0.17	0.72	24
	A2-G-6	7.38	164	242	468	1.9	5.0	59	25	250	23	0.20	0.62	27

All the values are expressed in mg/l except pH and EC. EC–micromho cm–1; Turbidity-NTU.

Fluoride: Fluoride occurs as fluorspar (fluorite), rock phosphate, triphite, phosphorite crystals etc. in nature. Among factors which control the concentration of fluoride are the climate of the area and the presence of accessory minerals in the rock mineral assemblage through which the ground water is circulating[18]. In this study, the fluoride concentration of all the sampling areas lies within the range of the permissible limit of WHO. The source of fluoride in these water samples may be weathering of rocks, phosphatic fertilizers used for agriculture or the sewage sludge[19]. The percolation of phosphatic fertilizers from the agricultural runoff from the nearby lands and discharge of domestic wastes or the wastes from the surrounding industries increases the fluoride values[20].

This study shows the all values are within the permissible level of WHO the concentration found during study period are between 1.10-0.12 ppm in residential areas it varies between 1.10-0.23 ppm whereas in mining areas its concentration varies with the values 0.77-0.12.

Iron: The main sources of iron in ground water are naturally as a mineral from sediment and rocks or from mining, industrial waste, and corroding metal[21]. The ranges of iron have been found in between 0.72-0.11 ppm in mining and residential area of Goramachia which is under WHO guidelines (1.0 ppm), from the table 1 it is also shown that all sites concentration is within the permissible limits of WHO. The high concentration of iron causes a bitter astringent taste to water and a brownish colour to laundered clothing and plumbing fixtures.

Chloride: Chloride occurs naturally in all types of water. Chloride in natural water results from agricultural activities, industries and chloride rich rocks. High concentration of chloride is due to the invasion of domestic wastes and disposals by human activities[22]. In the study areas chloride level is within the permissible limit of WHO (250 ppm), which indicates less contamination of chloride.

The ranges of chloride have been found in between 39-19 mg/l in mining and residential area of Goramachia. In residential area it has been found between the ranges of 39-19 mg/l where as in mining area Goramachia it has been found 35-34 mg/l, where as the two samples in the month January and May is not detected.

Conclusion

The groundwater of Goramachia area were collected and analyzed for various physico-chemical parameters. The results of the above work show that most of the physico-chemical parameters are well within the acceptable limit except some samples of E.C, Calcium, nitrate and D.O in mining areas in the month of January mostly exceeded the value of WHO. Dissolution of rock minerals with the ground water is a reason for pollution. The high access of contamination may be the outcome of high human, industrial and agricultural activities in their locality. All the above results confirm that the ground water quality is not up to the mark and is slowly degrading. Even though at present the condition is not very bad but if the same continues in future, the ground water source will be completely polluted and becomes unfit for portability and other purposes. It is time to preserve and protect this valuable ground

source. For this various measures have to be taken which will control the contamination from different sources. These include proper management of mining waste; proper way of mining technique and above all, the public awareness is must for the conservation of these precious ground water resources.

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