WATER QUALITY ANALYSIS OF NEAR MARBLE MINE AREA IN TEHSIL-KOTPUTALI, DISTRICT-JAIPUR, RAJASTHAN (INDIA)

Neha Saxena [(1)], Rajesh Kumar Yadav [(2)], Gaurav Sharma [(1)]

[(1)] Suresh Gyan Vihar University, Jaipur, India
[(2)] Department of Environmental Sciences,
S.S. Jain Subodh P.G. College, Rambagh Circle, Jaipur, India

* Corresponding author E-mail: neha.saxena0110@gmail.com

Abstract

Water is the most vital resources in our planet. From the different mining process the quality of ground water and surface water get contaminated by chemicals from mining. Further in processes creating environmental damage, the contamination resulting from leakage of chemicals also affects the health of the local population. To assess the quality of water two monitoring/sampling summer seasons were selected to analyses the quality of water near the marble mine in Tehsil - Kotputali, District- Jaipur (Rajasthan). Result shows that mining affects the quality of surrounding surface water and ground water. Observation showed a negative correlation with the water control. 20% results are within the permissible limits but 80 % results are above the permissible limits recommended by IS:3025 & APHA. The water is contaminated with high concentration of metals, types of toxic sulphides, and the presence of salts can negatively affect the water quality, marine life and ground water quality.

Keyword: *mining, sulphides, toxic, Jaipur*

Introduction

There is no disbelief that natural resources from the mining can contribute significantly to economic growth and development, of the industry (Mensah et al., 2015). In his mission and to satisfy his needs and aspirations for better living conditions through resource exploitation man has increasing day by day a number of environmental problems. He continuously exploits nature, and by this upset the natural resources get destroyed which is harmful to every living organism. Following each use of water and the exploitation of land and water resources, various forms of pollution contributes to the degradation of the environmental quality (Udiba et al. 2013). Currently, more actions and notifications taken towards to the Environmental Impact Assessment to assess out the various positive and negative impacts and suggest out the some mitigative measures to conserve the resources. The one of the most important resource is water; one of nature's, greatest gift to man is inexhaustible and can assimilate and diffuse anything put into it is fast fading out (Asuquo, 1999). Water is essential for every living organism. It is vital for the survival of man but also for other life form also (Asuquo, 1999). Freshwater quality and availability is one of the most critical

DOI: 10.6092/issn.2281-4485/7696

environmental and sustainability issues of the present century. Of all sources of freshwater on the Earth, groundwater constitutes over 90% of the world's readily available freshwater resources (Adedeji and Babatunde, 2010). Groundwater represents an important source of drinking water and its quality is currently threatened by a combination of over-abstraction and microbiological and chemical contamination (Aydin, 2007). The presence of metals in groundwater and soils can pose a significant threat to human health and ecological systems. The chemical form of the metal contaminant influences its solubility, mobility, and toxicity in ground-water systems and depends on the source of the metal waste, the soil and ground-water chemistry at the site. Metals differ from other toxic substances in that they are neither created nor destroyed by humans. Ground water may be contaminated with metals from wastewater discharges or by direct contact with metals-contaminated soils, sludge's, mining wastes, and debris. Metal-bearing solids at contaminated sites can originate from a wide variety of sources in the form of airborne emissions and process solid wastes (Ogabiela, 2011). Contamination of groundwater has severe implications for public health, particularly in small communities and developing countries where groundwater is often the preferred source of drinking water

The study has been conducted within the buffer zone called as the study area, seven sampling locations (including mine site) has been randomly selected to assess the impacts of marble mine on the water quality.

Materials and methods

Study area

Rajasthan is situated on the north-western part of India. It covers 3, 42,239 square kilometers (132,139 square miles).The study area is located about 10.5 km in NE direction is Kotputli town and is accessible from National Highway-8 which is approx 3.0 km in the SE direction of mine site. State Highway 37-B is at a distance of 7.0 Km in NNE Direction of mine site. The lease area is about 88 km away from Jaipur (i.e. District Headquarter). Table 1 shows the sampling locations, Figure1 show the location of the study area and Figure 2 show the sampling location of the study area.

Sampling Station	Sampling Location	Direction from Mine site	Approx. Aerial distance from Mining Lease Boundary (in km)
S1	Nr.Mine Site	-	-
S2	Village Bhaislana	SW	~2.0 km
S3	Village Dantil	W	~8.0 km
S4	Village Dhandha	WNW	~8.5 km
S5	Village Gordhanpura	E	~3.0 km
S6	Village Narhera	N	~6.5 km
S7	Town Paota	SSW	~ 7.0 km

Table 1
Locations of ground water sampling locations. Study period- summer season 2013 & 2014. Source: field survey/ SOI Toposheet

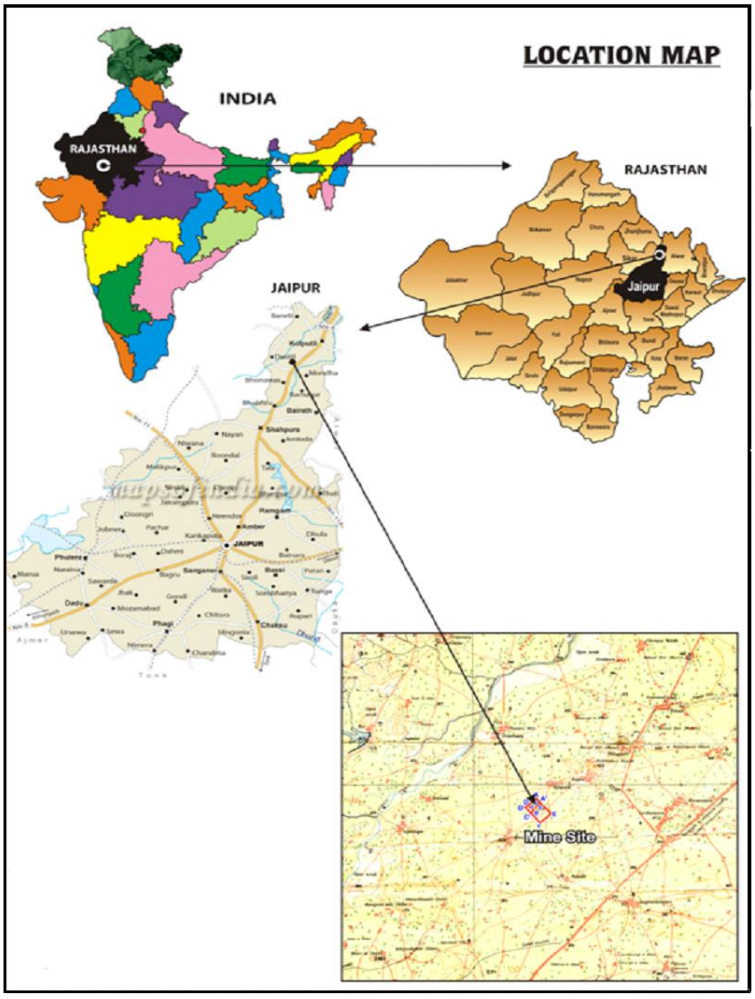

Figure 1
Show the location of the study area.

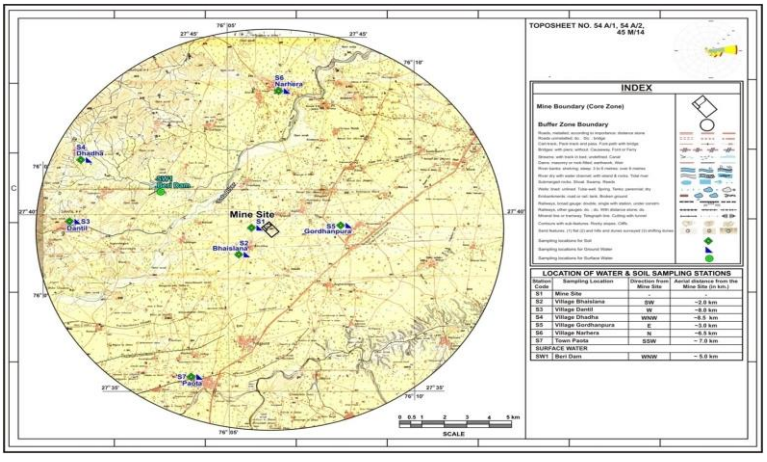

Figure 2
Sampling locations of the study area

DOI: 10.6092/issn.2281-4485/7696

Monitoring was done during summer season (April, May and June) for two seasons (2013 and 2014) from the study area. Results are shown in Table 2 and graphical representation of the same is shown in Figure 3.
The sources of potable water are the tube-wells, dug-wells, tap water and Hand pump in the area. Samples were collected from the available water resources around the mining lease area. The samples were collected and analyzed as per the procedures specified in "Standard Methods" for the examination of water *(www. epa.ie/pubs/advice/water/quality/Water_Quality.pdf) (http://mpcb.gov.in/envtdata/ LSD-NEERI-%20Water%20Quality%20Analysis.pdf).*

- pH (Hydrogen Ion Concentration): pH value of the sample will be directly determined by digital pH meter.
- Odor: odor of the sample will be checked by taking the sample in a clear bottle, shaking it thoroughly and determining the odor.
- Color: Color will be determined as variables in the unfiltered sample, immediately after collection.
- Turbidity (NTU): It will be determined by comparing the effluent samples with a pre- prepared standard solution of 10% Hexamine w/v H2O and hydrazine sulphate solution 1% with H2O. both the solution will be mixed in equal amounts and absorbance will be noted in the visible range. Turbidity is determined in Nephelometric Turbidity Units (NTU), by comparing the samples with the standard. Calculation:

$$\text{Turbidity (NTU)} = \frac{\text{X x Std. turbidity}}{\text{Absorbance (Standard)}} \quad [1]$$

where X is the difference between the absorbance of the unfiltered and filtered sample of the effluent water.
- Alkalinity: Alkalinity is the buffering capacity of a water body. It measures the ability of water bodies to neutralize acids and bases thereby maintaining a fairly stable pH. Total alkalinity (as $CaCO_3$) is determined by titrating 50ml of filtered solution against N/10, standard hydrochloric acid using methyl orange as indicator. Calculation:

$$\text{Total alkalinity (TA, as CaCO3) mg/l} = \frac{\text{Vol. of HCl consumed x Actual Normality of HCl x Factor x 100}}{\text{Taken Normality x Volume of sample taken}} \quad [2]$$

- Hardness: Total hardness will be calculated by using EDTA titration method. 100ml sample will be titrated by EDTA solution after addition of indicator (very small amount of Erichrome black T + 1ml Buffer solution) end point will be considered at the time of first color change (wine red to blue) and total hardness will be calculated by using the following formula:

$$\text{Total Hardness (mg/l)} = \frac{\text{Volume of EDTA x 1000}}{\text{Volume of sample taken}} \quad [3]$$

- Calcium: Calcium hardness will be determined in the sample by EDTA titration. 100ml of sample will be taken in a flask followed by the addition of muroxide

indicator and 1ml of 1N NaOH then sample will be titrated by standard EDTA solution till color changes from pink to purple and calculation will be as per the following formula:

$$\text{Ca (mg/l)} = \frac{\text{Volume of EDTA x 400.8}}{\text{Volume of sample taken}} \quad [4]$$

- Magnesium: it will be calculated by using following formula:

$$\text{Mg hardness (mg/l)} = \text{Total Hardness} - \text{Calcium Hardness x 0.0244} \quad [5]$$

where: calcium hardness = calcium (mg/l) X 2.497

- Chloride: Chloride in waste water sample will be determined by the titration method. In this method, a known amount of sample is taken in an erlymeyer flask followed by the addition 1ml of $K_2Cr_2O_7$ indicator. It is then titrated with (0.2N) silver nitrate ($AgNO_3$) solution, change in color of bright red consider as end point and the calculation is made according to:

$$\text{Chloride (mg/l)} = \frac{\text{Volume of } AgNO_3 \text{ x Normality of } AgNO_3 \text{ x 1000 x 35.5}}{\text{Volume of sample taken}} \quad [2]$$

- Total Dissolved Solids (TDS): A well mixed sample is filtered through a prepared glass fiber filter into a clean filter flask. The portion of the sample that is not retained by the filter is the dissolved solids. The filter is dried to a constant weight at 180 degrees Celsius and the difference in the weight of the dish represents the dissolved solid concentration. Dissolved solids are those that pass through a water filter. They include some organic materials, as well as salts, inorganic nutrients, and toxins.

Results and discussion

Water Analysis

The quality of ground water was studied by collecting 7 water samples from representative open dug wells and tube wells has been taken at different location.

- pH. pH value ranged between in Summer Season 2013 is 7.5±0.08 to 8.0± 0.13 and in Summer Season 2014 is 7.3±0.07 to 7.8±0.20. The pH value showed that water samples are alkaline in nature and these values were within the limit as prescribed by APHA for all samples. The minimum value of pH was monitored in Summer Season 2013 in Village–Dantil and the maximum value of pH was viewed in sample Village-Gordhanpura. In the summer season 2014 the minimum value observed in Town-Paota and Village-Dantil whereas the maximum value monitored in Village-Bhaislana.

- Total Dissolved Solids (TDS). TDS Values were varied from 2669±118.8 to 3457±227.3in Summer Season 2013 whereas in Summer Season 2014 TDS value monitored from 2089±410.2 to 2940±199.0 and all samples above the permissible limit prescribed by IS:3025 and APHA (https://archive.org/details/gov.in.is.3025.01.1987) (http://aphastandards.nsf.org/apps/grouppublic/download.php/10299/4i5r2

DOI: 10.6092/issn.2281-4485/7696

%20Normative%20References%20Only.pdf). In Summer Season 2013 the minimum value observed in Mine Site and in the Village–Dantil maximum Value was surveyed .In the Summer Season 2014 the minimum value observed in Town-Paota and maximum value viewed in Village-Narhera.

Table 2. *Ground Water Quality Analysis Study Period –Summer Season 2013 and 2014*

S. No.	Parameters	Sampling Locations							Control
		Mine Site	Village Bhaislana	Village Dantil	Village Dhandha	Village Gordhanpura	Village Narhera	Town Paota	
	Summer 2013								
1.	**pH**	7.5 ±0.14	7.7 ±0.04	7.5 ±0.08	7.6 ±0.14	8.0 ±0.13	7.9 ±0.22	7.7 ±0.21	8.5-9.5
2.	**Colour (Hazen Unit)**	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	25
3.	**Turbidity (NTU)**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	10
4.	**Odour**	UNO	UNO	UNO	UNO	UNO	UNO	UNO	-
5.	**Taste**	AGR	AGR	AGR	AGR	AGR	AGR	AGR	**-**
6.	**Total Hardness as CaCO3 (mg/l)**	658.9 ±48.8	622.2 ±67.9	592.4 ±63.5	604.2 ±75.3	600.5 ±67.4	562.8 ±83.9	589.3 ±81.0	600
7.	**Calcium as Ca (mg/l)**	394.4 ±36.3	364.6 ±28.2	296.2 ±22.3	329.1 ±19.4	377.8 ±22.1	329.2 ±16.4	318.3 ±19.8	200
8.	**Alkalinity as CaCO3, (mg/l)**	567.1 ±71.5	569.8 ±63.0	539.8 ±48.7	566.6 ±65.7	600.5 ±67.4	539.9 ±72.8	581.4 ±86.7	600
9.	**Chloride as Cl (mg/l)**	1372 ±80.8	1440 ±55.8	1435 ±70.0	1365 ±62.0	1524 ±59.7	1366 ±62.1	1398 ±44.0	1000
10.	**Magnesium as Mg (mg/l)**	296.5 ±43.4	334.5 ±23.7	296.2 ±22.3	329.1 ±19.4	350.0 ±27.0	318.1 ±15.2	314.7 ±20.0	100
11.	**Total Dissolved Solids (mg/l)**	2669 ±119	2943 ±230	3457 ±227	2712 ±391	3232 ±237	3703 ±222	3150 ±263	2000
	Summer 2014								
1.	**pH**	7.7 ±0.13	7.6 ±0.19	7.3 ±0.07	7.5 ±0.13	7.5 ±0.13	7.8 ±0.20	7.3 ±0.07	8.5-9.5
2.	**Colour (Hazen Unit)**	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	25
3.	**Turbidity (NTU)**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	10
4.	**Odour**	UNO	UNO	UNO	UNO	UNO	UNO	UNO	-
5.	**Taste**	AGR	AGR	AGR	AGR	AGR	AGR	AGR	**-**
6.	**Total Hardness as CaCO3 (mg/l)**	685.7 ±94.4	761.8 ±23.8	676.1 ±28.3	689.1 ±42.4	686.5 ±52.5	623.7 ±58 3	629.0 ±41.3	600
7.	**Calcium as Ca (mg/l)**	352.2 ±31.2	343.4 ±34.2	278.5 ±10.8	278.8 ±19.0	319.5 ±25.9	305.5 ±11.3	279.4 ±12.8	200
8.	**Alkalinity as CaCO3, (mg/l)**	729.5 ±22.8	694.8 ±54.2	619.9 ±20.6	553.4 ±19.2	633.5 ±37.8	630.1 ±68.5	597.4 ±64.3	600
9.	**Chloride as Cl (mg/l)**	1177 ±74.6	1090 ±43.4	1289 ±61.3	1392 ±93.3	1359 ±84.2	1163 ±73.7	1411 ±43.7	1000
10.	**Magnesium as Mg (mg/l)**	281.7 ±26.5	311.8 ±11.0	239.8 ±20.2	278.2 ±21.6	251.5 ±31.9	301.0 ±22.1	266.9 ±15.7	100
11.	**Total Dissolved Solids (mg/l)**	2317 ±107	2690 ±175	2940 ±199	2503 ±328	2213 ±398	2885 ±165	2089 ±410	2000

Mean ±SE (Standard Error), n=6 - UNO = Unobjectionable - AGR = Agreable

- Chloride(Cl^-). Chloride values ranged from 1365±62.0 to 1524±59.7 in summer season 2013 and in the Summer Season 2014 the values varied from 1090±43.4 to 1411±43.7.The results shown that the samples are above the permissible limits recommended by IS:3025 & APHA. The minimum value of Chloride was found in Water Sample Village-Narhera and the maximum value of Chloride detected in Village-Bhaislana in Summer Season 2013.From Summer Season 2014 we have observed that the minimum value was detected in Village- Bhaislana whereas maximum value surveyed in Village-Dandha.

- Calcium (Ca^{2+}). Calcium Values were varied from 296.2±22.3 to 394.4±36.3 in Summer Season 2013.In the Summer Season 2014 the values were found between 278.5±10.8 to 352.2±31.2. Results are above the permissible limit by IS: 3025 & APHA. The minimum value of Calcium found in Village-Dantil and maximum value find in Mine Site in Summer Season 2013 .In summer season 2014 the minimum value observed in Village–Dantil and the maximum value found in Mine Site.

- Magnesium (Mg^{2+}). The data reveals that the magnesium values varied from 296.2±22.3 to 350.0±27.0 in summer season 2013 whereas in summer season 2014 the minimum value were 251.5±31.9 and the maximum value was 311.8±11.0. 20% results are within the permissible limits but 80% results are above the permissible limits recommended by IS:3025 & APHA. The minimum value of sample was observed in sample Village-Dantil and maximum value surveyed in Village-Gordhanpura in 2013 study. In 2014 the minimum value were found in Village-Gordhanpura and maximum value find in Village-Bhaislana.

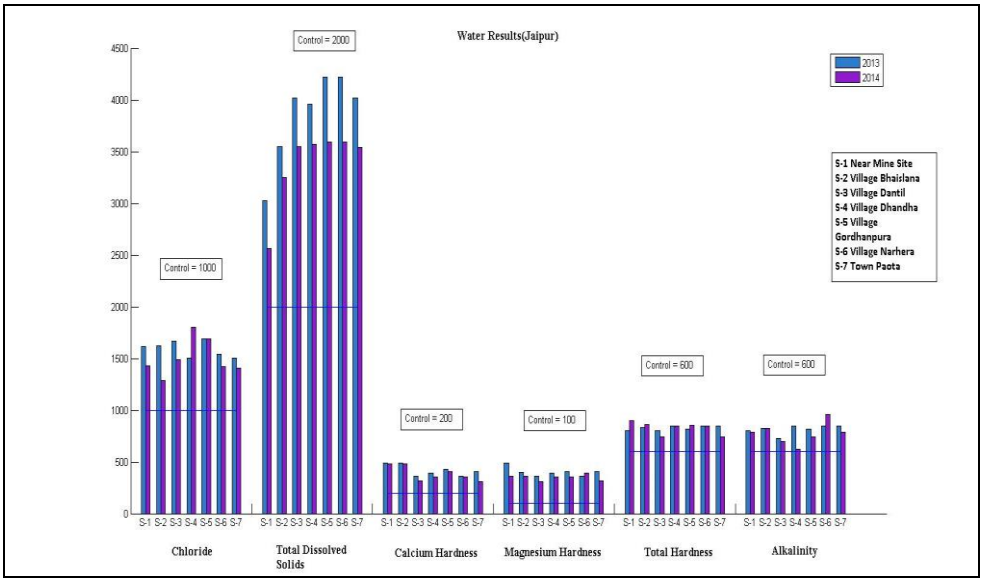

Figure 3. *Comparative studies showing the results of air in Summer season 2013 and 2014*

- Total Hardness (TH). TH Values were varied from 562.8±83.9 to 658.9±48.8 in 2013 and in 2014 the value varied from 623.7±58.3 to 761.8±23.8.Results are

DOI: 10.6092/issn.2281-4485/7696

shown that 10% in the permissible limits where as 90% above the permissible limits as recommended by IS:3025 & APHA. Minimum value ob served in Village-Narhera and maximum value found in Mine Site in 2013. In 2014 the minimum value found in Village-Narhera and maximum observed in Village-Bhaislana.

- **Alkalinity.** Alkalinity values varied in 2013 from 539.8±48.7 to 600.5 ±67.4; in 2014 from 553.4±19.21 to 729.5±22.8. Results are found above the permissible limits as prescribed by IS:3025. The minimum sample was surveyed in Village-Dantil and the maximum Value observed in Village-Gordhanpura. In 2014 the minimum value observed in Village-Dandha and maximum in Mine Site.

In the present study, Observation showed a negative correlation with the water control. By using the Analysis of Variance (ANOVA) we have found that results are statistically significant or not ($P<0.05$). The pH of the sources of water studied area ranged from 7.3 to 8.1 in both the sampling season .This implies that majority of water samples in the study area are alkali in nature. It has also found that higher pH level in most of the samples was associated with the higher concentration of alkalinity.

The hardness of water is imparted by Calcium and Magnesium ions which are in combination with bi-carbonate in addition to sulphate, chloride and nitrate. The desirable limit of hardness in drinking water is permissible limit is 600mg/l. In the present study, it varied from 562 to 658 mg/l in Summer Season 2013. From control near mine site and town Paota was significant. In the range between 623 to 761 mg/l found in Summer season 2014. From control Village-Bhaislana, Village-Narhera was found significant. Investigations of the present study showed a negative correlation with the control.

Calcium occurs naturally in all the water resources. The solubility of calcium is governed by the carbonate/bicarbonate equilibrium and therefore it is strongly recommended by temperature and pH. In the study area 2013 calcium content was observed significant ($P<0.05$)* where the adjusted P value is 0.0185 and the R Square is 0.5301. In the Summer Season 2013 Control were found significant with Village-Bhaislana, Village-Dandha, Village-Gordhanpura, Village-Narhera and Town Paota whereas in Summer season 2014 the results were also find significant ($P<0.05$)* the adjusted P Value is 0.0223 and the R Square is 0.4988 in which the Control is significant with near Mine Site, Village-Dantil, Village-Narhera and Town-Paota. The Calcium richness in groundwater that was associated with the concentration of calcium content and high pH level due to the dominate presence of sodium bi carbonate in the ground water.

Magnesium in the present study, it was observed that the results were found significant with ($P<0.05$)** in which the adjusted P Value is 0.0015 and the R square is 0.659 which shows the statistically significant in Summer Season 2013. From the control Village Bhaislana, Village-Dantil, Village-Dandha, Village-Gordhanpura, Village Narhera and Town-Paota were found statistically significant. From the Summer Season 2014 we have observed that the results was statistically significant ($P<0.05$)** in which the adjusted P Value is 0.0012 and the R Square is

06614. From the Control all the water samples were found significant. Magnesium concentration is less than the Calcium concentration.

Total Dissolved Solids is an expression of combined content of all inorganic and organic substances in a liquid. The principle application of TDS is in the study of ground water, streams, rivers and lakes. In the present study in 2013 the results were observed statistically significant (P<0.05)* where the adjusted P Value is 0.0262 and the R square is 0.4961. From the summer season 2013 the control was significant with near Mine Site, Village-Dantil, Village-Gordhanpura, Village Narhera and Town–Paota. In the 2014 the results was not statistically where as the P Value is 0.1875 and the R square is 0.2794. Control was significant with Village-Dantil and Village-Narhera.

Alkalinity due to carbonate and bi-carbonate ions .Alkalinity is a measure of the capacity of water to neutralize acids. The predominant chemical system present in natural water is one where carbonates, bi carbonates and hydroxides are present. The bi-carbonate ion is usually prevalent. Alkalinity shows the positive correlation with the calcium Hardness and pH .In the Summer Season 2013 the results were found statistically significant (P<0.05)* the adjusted P Value is 0.0184 and the R square is 0.3045.Control was found significant with Village-Dandha and Village-Gordhanpura. From the summer Season 2014 results observed that statistically significant (P<0.05)** where the adjusted P value is 0.0054 and the R Square is 0.2802. From the Control Near mine site was significant .Near mine site was significant with Village-Dandha.

Conclusions

Results of the study show that mining activities have significant effects on the environment. Mining affects environment adversely. From the present study we can observed that Mining affects the quality of surrounding surface water and ground water. The water is contaminated with high concentration of metals, types of toxic sulphides, and the presence of salts can negatively affect the water quality, marine life and ground water quality. Because of mining the water can impact the marine life can include mortality, health or reproductive problems and a reductions of species present. The impact occurs on the human health and the quality of the water used for irrigation; drinking and or industrial application is affected.

Perhaps the most significant impact of a mining project is its effects on water quality and availability of water resources within the project area. Key questions are whether surface and groundwater supplies will remain fit for human consumption, and whether the quality of surface waters in the project area will remain adequate to support native aquatic life and terrestrial wildlife villages. (https://www.elaw.org/files/mining-eia-guidebook/Chapter1.pdf).

From the study we have conclude that it's really important to take a various mitigative measures to protect the environment or the surrounding area

Acknowledgments

DOI: 10.6092/issn.2281-4485/7696

The author wishes to express special thanks to Dr. Rajesh Kumar Yadav, Head of Department of Environmental sciences, S.S. Jain Subodh P.G. College, who supervised the research work and providing me Lab facility and etc. The authors are thankful to the Journal for the support to develop this document. The authors thank anonymous reviewers who provided thoughtful review comments that significantly improved the paper. There is no funding Source.

Conflict of Interest

The authors have declared no conflict of interest.

References

ASUQUO F.E. (1999) Physicochemical Characteristics and Anthropoenci Pollution of the Surface Waters of Calabar river, Nigeria. Global J. Pure and Applied Science, 5:595–600.

ADEDEJI A., BABATUNDE A. (2010) Quality of hand-dug wells in selected locations in Lagos coastal aquifer, Nigeria. Report and Opinion, 2(3):51-54.

AYDIN A. (2007) The microbial and physico-chemical quality of groundwater in West Thrace, Turkey. Polish J. of Environ. Stud. 16(3):377-383.

MENSAH A.K., MAHIRI I.O., OWUSU O., MIREKU O.D., WIREKO I., KISSI E.A.(2015) Environmental impacts of mining: a study of mining communities in Ghana. .Applied Ecology and Environmental Sciences, 3(3):81-94. Doi: 10.12691/aees-3-3-3

OGABIELA E. E, OKONKWO E.M., OKLO A.D., UDIBA U.U., HAMMUEL C., ADE-AJAYI A.F., MAHMUD A. (2011) Status of trace metal levels of different age population of Dareta Village, Anka, Nigeria. Journal of Applied Environmental and Biological Sciences, 1(6):96-100.

UDIBA U.U., INUWA B., NSIKAK A. S., SIKEMI O., UDUAKOBONG. I., EVERLYN. O.H., VICTORIA1 U., STELLA A.. AGBOUN T. D. T. (2013) Impact of mining activities on ground water quality status, Dareta Village, Zamfara, Nigeria. Archives of Applied Science Research, 5(1):151-158.